Minutes of Meeting
Bachelor of Technology
(Computer Science & Engineering)

[Applicable w.e.f. Academic Session 2025-26 till Revised]

FACULTY OF ENGINEERING & TECHNOLOGY

COURSE STRUCTURE

RAMA UNIVERSITY, UTTAR PRADESH, KANPUR

Website: www.ramauniversity.ac.in

Ref: RU/FET/CSE/BOS/2025/001

Dated: 19-Aug-2025

Faculty of Engineering & Technology

Department of Computer Science & Engineering

Minutes of Meeting

Boards of Studies

A meeting of Boards of Studies of Computer Science & Engineering (B. Tech.) held on 19-Aug-2025 in Dean Office. The following members were present:

1. Dr. Indrajeet Gupta - Chairperson
2. Dr. Abhay Shukla - Member
3. Dr. Somendra Tripathi - Member
4. Dr. Neeraj - Member

The following members agreed to review the minutes online meeting mode.

1. Dr Tapas Badal - External Member
2. Dr. Vandana Dixit Kaushik - External Member
3. Dr. Shubha Jain - External Member
4. Mr. Lokesh Mehra - External Member
5. Mr. Talha Jawed - External Member

Agenda Items

1. **Proposed Change in the Scheme:**
   - ✓ Review and approval of modifications in the academic scheme for upcoming sessions.
2. **Proposed Change in the Credits and Course Nomenclature:**
   - ✓ Discussion on aligning course credits and titles as per updated academic and industry requirements.
3. **Proposed Change in Syllabi and Introduction of New Evaluation Scheme:**
   - ✓ Examination and approval of revisions in existing syllabi to meet emerging technological trends.
   - ✓ Introduction and implementation of a new evaluation scheme for better assessment of student learning.
4. **Incorporation of MOOCs in Syllabus**
   - ✓ Integration of Massive Open Online Courses (MOOCs) into the curriculum to enhance learning outcomes.
5. **Incorporation of Flipped Classroom Approach**
   - ✓ Adoption of flipped classroom methodology to improve student engagement and practical learning.
6. **Revision of External Examiner Panel**
   - ✓ Review and update of the panel of external examiners for various courses and programs.

The BOS committee confirmed the minutes of the BOS meeting held on 19-Aug-2025

1. **Action Taken Report (ATR) in Minutes of Previous Meeting**
   The BOS Committee confirmed the minutes of the BoS Meeting Held on 10 May 2024.
   The BOS Committee discussed on Action Taken Report on the basis of result analysis of session 2023-24 (Even) and 2024-25 (Odd Semester).

2. **R-25 Specialization**
   The committee, vide Ref. No. FET/CSE/DO/2025/07-28 dated 28 July 2025, approved the introduction of the following specializations under the R-25 scheme to meet industry requirements and align with NEP 2020 and AICTE 2022 guidelines.
   - a- Artificial Intelligence
   - b- Data Science
   - c- Internet of Things
   - d- Cloud Computing & DevOps
   - e- Cyber Security

3. To consider and approve new Evaluation Scheme and Syllabus.

S. No.	Item No	Feedback from Faculty and Student	Action Taken / Remarks
1	**RU/FET/CSE/BOS/2025/BTECH/001**	**Proposed Change in the Scheme** Students and faculty suggested revising the existing scheme to reduce redundancy, ensure better alignment with industry trends, and incorporate multidisciplinary flexibility as per NEP 2020.	The committee took the decision to revise the scheme under **R-25**, restructuring the curriculum to ensure flexibility, skill-based learning, and alignment with NEP 2020 provisions.
2	**RU/FET/CSE/BOS/2025/BTECH/002**	**Proposed Change in the Credits and Course Nomenclature** Faculty emphasized rationalizing credits to balance workload; students requested clarity and uniformity in course titles to match industry standards.	The committee took the decision to rationalize credits as per **AICTE 2022 guidelines** and update course nomenclature to reflect industry relevance.
3	**RU/FET/CSE/BOS/2025/BTECH/003**	**Proposed Change in Syllabi and Introduction of New Evaluation Scheme** Feedback from both **faculty and students** highlighted the need to revise the existing syllabi by incorporating modern and industry-relevant subjects such as **Artificial Intelligence, Robotics, Cloud Computing, Cybersecurity, and Generative AI**. It was also emphasized that the evaluation process should shift towards a more holistic and skill-oriented model, with increased focus on **continuous assessment methods** including projects, assignments, seminars, certifications, and class participation.	The committee reviewed and approved the R-25 Assessment Components, which are structured as: CA: 30 Marks, MTE: 20 Marks, and ETE: 50 Marks, Total 100 Marks. For Continuous Assessment (CA), the distribution will be: Attendance – 10 Marks, and Assignments/Quiz/Seminar/Term Paper/Certificate/Class Project – 20 Marks. The committee also resolved to update the syllabi by incorporating industry-oriented courses and emerging technologies, along with introducing a revised evaluation scheme that places greater emphasis on projects, assignments, and continuous assessment.
4	**RU/FET/CSE/BOS/2025/BTECH/004** (In reference with Circular No: RU/DA/2025/020 Dated: 28 July 2025)	**Incorporation of MOOCs in Syllabus** Faculty and students requested flexibility to pursue online courses (SWAYAM, NPTEL, Coursera) for skill enhancement.	The committee took the decision to incorporate MOOCs in the curriculum, allowing credit transfer (up to 20%) as per **AICTE norms**.
5	**RU/FET/CSE/BOS/2025/BTECH/005**	**Incorporation of Flipped Classroom Approach** Students preferred interactive and practice-oriented sessions; faculty supported blended learning to increase participation.	The committee took the decision to formally introduce the flipped classroom pedagogy and circulate guidelines to faculty for effective implementation.
6	**RU/FET/CSE/BOS/2025/BTECH/006**	**Course Bucket Structure under R-25**	The committee took the decision to approve the following bucket structure under **R-25**: • **Specialization Core I & II Bucket – 26 Courses**

		Students and faculty suggested increasing elective choices and introducing structured specialization options.	• **Specialization Elective Bucket – 46 Courses** • **Professional Elective Bucket – 23 Courses** • **Open Elective Bucket – 23 Courses**

4. The experts suggested shifting the subject **BCS4005 – Operating System** from IV Semester to III Semester. After detailed discussion, the BoS members agreed to revise the structure by placing **BCS3002 – Operating System** in the III Semester and shifting **BCS4005 – Computer Organization and Architecture** to the IV Semester.
5. The experts suggested introducing a **Multiple Entry and Exit** option. In response, it was decided that the matter will be taken up for detailed discussion in the next BoS meeting (December 2025) in line with university norms.
6. **Revision of External Examiner Panel** Faculty recommended updating the panel to include experts from both academia and industry.

   The committee took the decision to revise the external examiner panel, including **industry experts and academicians** from reputed institutions.

7. Question Paper Format: The question paper format, as per NAAC/NBA requirements, includes a dedicated column for CO (Course Outcome) mapping against each question. This ensures clear alignment of assessment items with defined learning outcomes, facilitates transparent evaluation, and supports accreditation compliance through measurable and outcome-based education practices.
8. It was clarified that the **R-25 curriculum and evaluation scheme shall be applicable only from the academic session 2025–26 onwards.** The students admitted in earlier sessions will continue to follow the curriculum and regulations approved under the previous BoS.

The meeting concluded with a vote of thanks to the chair.

Date of the Next Meeting: to be decided and conveyed later

Chairperson

Signature: .....

Name: Dr. Indrajeet Gupta

Date:

Internal Members

Signature: 1..... 2..... 3.....

Name: Dr. Abhay Shukla Name: Dr. Somendra Tripathi Name: Dr Neeraj

External Members

Signature: 1..... 2..... 3.....

Name: Dr. Tapas Badal Name: Dr. Vandana Dixit Kaushik Name: Dr. Shubha Jain

Signature: 4..... 5.....

Name: Mr. Lokesh Mehra Name: Mr. Talha Jawed

Date: 28/08/2025

Encl.: Recommended Curriculum attached for consideration and approval.

CC:

1. Dean
2. Registrar Office

Program Educational Objectives

At Rama University Computer Science and Engineering program will prepare its graduates to:

PEO 1: Work productively as successful Computer professionals in diverse career paths including supportive and leadership roles on multidisciplinary teams or be active in higher studies,

PEO 2: Communicate effectively, recognize and incorporate societal needs and constraints in their professional endeavors, and practice their profession with high regard to ethical responsibilities,

PEO 3: Engage in life-long learning and to remain current in their profession to foster personal and organizational growth.

Program Specific Outcomes

- Apply standard Software Engineering practices and strategies in real-time software project development using open-source programming environment or commercial environment to deliver a quality product for the organization success
- Design and develop computer programs/computer-based systems in the areas related to algorithms, networking, web design, cloud computing, IoT, AI and data analytics of varying complexity
- Acquaint with the contemporary trends in industrial/research settings and thereby innovate novel solutions to existing problems

Program Outcomes:

PO1 - Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 - Problem analysis: Identity, formulates, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 - Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, social, and environmental considerations.

PO4 - Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis, and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 - Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 - The engineer and the world: Apply reasoning to assess societal, health, safety, legal, cultural, and environmental issues, demonstrating responsibility for sustainable development in engineering practice.

PO7 - Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO8 - Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO9 - Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO10 - Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO11 - Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Chairperson

Signature: .....

Name: Dr. Indrajeet Gupta

Date:

Internal Members

Signature: 1..... 2..... 3.....

Name: Dr. Abhay Shukla | Name: Dr. Somendra Tripathi | Name: Dr Neeraj

External Members

Signature: 1..... 2..... 3.....

Name: Dr. Tapas Badal | Name: Dr. Vandana Dixit Kaushik | Name: Dr. Shubha Jain

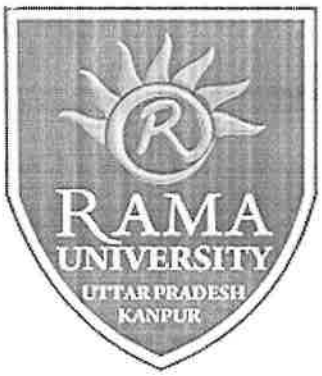
Signature: 4..... 5.....

Name: Mr. Lokesh Mehra | Name: Mr. Talha Jawed | Date: 28/08/2025

Course Curriculum (w.e.f. Session2025-26)

B. Tech. Computer Science & Engineering

ORDINANCE
For
Bachelor of Technology (B.Tech)
In
Computer Science and Engineering
with specialization in
Internet of Things (IoT)



Faculty of Engineering, Rama University

Preamble

This Ordinance governs the Bachelor of Technology (B.Tech) programme offered in the Faculty of Engineering, Rama University, in Computer Science & Engineering with specializations in Internet of Things (IoT) . The provisions herein define the framework, policies, academic regulations, and structural guidelines that regulate the operation of the programme. The aim is to provide a comprehensive understanding of the curriculum structure, admission norms, evaluation procedures, and student responsibilities. This ordinance is designed in line with AICTE, UGC, and National Education Policy (NEP-2020) guidelines.

1. Program Name & Code

PROGRAM NAME: **BTech in Computer Science and Engineering with specialization in Internet of Things (IoT)**
PROGRAM CODE:

The Bachelor of Technology (B.Tech) is an Undergraduate (UG) programme in Engineering. It is offered in Rama University under the Faculty of Engineering. The B.Tech program has been designed to prepare graduates with strong fundamentals, practical exposure, and research aptitude.

2. Eligibility Criteria

First Year Admission (Regular Entry):

Candidates shall be eligible for admission to the First Year of the Four-Year B.Tech. programme of the Faculty of Engineering & Technology, Rama University, Kanpur, if they have passed the 10+2 examination or its equivalent, conducted by U.P. Board, CBSE, ISC, any recognized State Board, or the National Institute of Open Schooling (NIOS), with a minimum of 50% aggregate marks in Physics and Mathematics, along with any one of Chemistry / Computer Science as a compulsory subject combination.

Second Year Admission (Lateral Entry):

Candidates who have successfully completed a Three-Year or Four-Year Diploma in Engineering/Technology with a minimum of 50% marks from an institution recognized by the Board of Technical Education or a University, in any branch of Engineering/Technology except Agriculture Engineering, shall be eligible for direct admission to the Second Year of the B.Tech. programme.

3. Admission Procedure

Admission to the programme shall be governed by the provisions of the Acts, Statutes, and Ordinances of Rama University, as in force and as may be amended from time to time. The admission shall be granted strictly on the basis of merit determined through the Entrance Test conducted by Rama University.

Provided further that, while granting admission to the programme, the reservation policy of the Government of Uttar Pradesh, as applicable to admissions in higher educational institutions and as notified from time to time, shall be duly implemented.

4. Duration of the Programme

The Bachelor of Technology (B.Tech) in Computer Science & Engineering with specializations in Internet of Things (IoT) programme shall comprise regular study over a minimum period of eight semesters spanning four academic years. The course of study shall be pursued through regular attendance in the prescribed number of lectures, tutorials, laboratory work, seminars, industrial training, projects, and such other academic components as may be specified in the scheme of examination.

Ordinarily, the first semester shall commence from 1st August, and the other odd semesters (III, V, VII) shall ordinarily be conducted from 1st July to 31st December, while the even semesters (II, IV, VI, VIII) shall ordinarily be conducted from 1st January to 30th June. These periods shall include the time allocated for examinations and may be modified from time to time as notified by the Vice-Chancellor or other competent authorities.

The total duration of the Bachelor of Technology (B.Tech) in Computer Science & Engineering with specializations in Internet of Things (IoT) programme shall be four years, each academic year comprising two semesters, with each semester normally consisting of at least 90 working days, or as otherwise prescribed by the UGC/AICTE or other statutory bodies from time to time.

5. Maximum Duration for Completion

A candidate admitted to the First Semester of the B.Tech. programme shall be required to complete all prescribed requirements for the award of the degree within a maximum period of seven (7) years from the date of initial admission.

A candidate admitted to the Third Semester of the B.Tech. programme through Lateral Entry (Diploma holders) shall be required to complete all prescribed requirements for the award of the degree within a maximum period of five (5) years from the date of initial admission.

Failure to complete the programme within the stipulated maximum duration shall render the candidate ineligible to continue and the candidature shall stand cancelled automatically.

6. Medium of Instruction

The medium of instruction, course delivery, examinations, assignments, and laboratory work shall be strictly in English. Students are encouraged to improve communication skills in English through remedial and language enhancement courses offered by the University.

7. Structure of the Programme

The Bachelor of Technology (B.Tech) in Computer Science & Engineering with specializations in Internet of Things (IoT) programme is a four-year, eight-semester undergraduate programme designed in accordance with the guidelines of NEP-2020, UGC, and AICTE.

- **Basic Science Courses (BSC):** Build foundational knowledge in Mathematics, Physics, Chemistry, and related sciences essential for engineering applications.
- **Engineering Science Courses (ESC):** Introduce fundamental engineering concepts and tools, including problem-solving, programming, electrical sciences, electronics, and mechanical systems.
- **Professional Core Courses (PCC):** Provide strong technical grounding in core areas of Computer Science and Engineering, including algorithms, programming paradigms, operating systems, databases, computer networks, software engineering, and artificial intelligence.
- **Professional Specialization Core (PSEC):** Offer advanced knowledge in emerging domains of CSE, enabling students to gain domain-specific expertise.
- **Professional Electives (PEL):** Allow students to select advanced courses from within the discipline to specialize in areas such as Artificial Intelligence, Cyber Security, Cloud Computing, and Data Science.
- **Open Electives (OE):** Encourage interdisciplinary learning by allowing students to opt for courses offered by other faculties and departments.
- **Humanities and Social Sciences (HSC):** Develop life skills, communication, ethics, entrepreneurship, and professional values.
- **Mandatory Courses (MC) & Ability/Value/Skill Enhancement Courses (AUC):** Strengthen universal human values, environmental awareness, and co-/extra-curricular engagement.
- **Laboratory and Practical Courses:** Provide hands-on learning aligned with theory courses, enhancing technical and problem-solving skills.
- **Seminar and Project Work:** Improve communication, teamwork, innovation, and technical presentation abilities.
- **Capstone Project & Dissertation:** Foster innovation, research aptitude, and the ability to apply engineering knowledge to real-world challenges.

- **Internships/Professional Practice:** Expose students to industry practices, startups, and professional environments, equipping them with employability skills.

8. Marks/Credit Distribution

The Bachelor of Technology (B.Tech) in Computer Science & Engineering with specializations in Internet of Things (IoT) programme spans eight semesters across four academic years. It is designed to provide a progressive blend of core theory, laboratories, electives, specialization courses, project-based learning, internships, and research exposure. The curriculum gradually transitions from basic sciences and engineering fundamentals in the first year to professional core, specialization, and electives in the second and third years, culminating in capstone projects, internships, and dissertation work in the final year. This ensures a balance of academic depth, practical training, innovation, and industry orientation, in alignment with NEP-2020, UGC, and AICTE guidelines.

Semester	Course Type Included	Total Credits
I	Basic Science Courses + Engineering Science Courses + Core Labs + Skill Courses	20
II	Basic Science + Professional Core (Foundations) + Humanities & Social Science + Labs + Mandatory Courses	20
III	Professional Core (OS, IMS, Algorithms, AI/ML) + Specialization Core-I + Labs + Humanities	25
IV	Professional Core (Networks, Software Engg., Cloud, Discrete Maths) + Specialization Core-II + Labs + Environmental Studies	23
V	Professional Core + Professional Electives + Labs + Open Electives + Co-/Extra Curricular Courses	23
VI	Professional Core + Specialization/Professional Electives + Labs + Internship/Industry Exposure + Skill Courses	20
VII	Open Electives + Professional Electives + Capstone Project with Design Thinking / Industry Project	16
VIII	Open Elective-III + Major Project / Industrial Project / R&D Project / Internship	15

9. Evaluation Procedure

The evaluation scheme is divided into Continuous Evaluation (CE) and End Term Examination (ETE).
Continuous Evaluation (CE) divided into
Continuous Assessment (CA) and Mid Term Examination (MTE)
Assessment Components, are structured as:

CA: 30 Marks,
MTE: 20 Marks,
and ETE: 50 Marks, Total 100 Marks.

Continuous Assessment (CA), the distribution will be:

i) Active participation of students in academic and co-curricular activities, including but not limited to seminars, Student Development Programme (SDP), workshops, and allied engagements, shall be in accordance with the stipulations contained in Circular No. RU/DA/2025/025 dated 25-08-2025. **– 10 Marks**

ii) Assignments/Quiz/Seminar/Term-Paper/Certificate/Class-Project **– 20 Marks.**

Mid Term Examination (MTE) **-20 Marks**
includes written theory papers, viva voce, and practical examinations conducted by internal examiners

End Term Examination (ETE) **– 50 Marks**
includes written theory papers, viva voce, and practical examinations conducted by internal and external examiners.

Minor Project / Professional Practical Internship-I (VII Semester)
Marks Distribution: CA – 100, MTE – 100, ETE – 300 (Total = 500 Marks)
Continuous Assessment (CA): Based on progress reports, seminars, presentations, and performance during sessions with the assigned supervisor/mentor.
Mid-Term Evaluation (MTE): Conducted by an internal evaluation committee to assess the progress of the project/internship work.
End-Term Evaluation (ETE): Conducted by a Board of Internal and External Examiners appointed by the Dean, Faculty of Engineering & Technology.
Guidelines:
Each student shall undertake a Minor Project / Internship under the supervision of a faculty guide/supervisor, appointed by the Dean.
A minimum of two bound copies of the Project Report along with one soft copy (PDF/CD) must be submitted at least two weeks prior to the commencement of the End-Semester Examination of the VII Semester.
The evaluation shall be based on:
Relevance of the problem identified and objectives.
Methodology, technical approach, and use of tools/technologies.
Innovation, originality, and application to industry/societal needs.
Quality of report writing, formatting, and referencing.
Seminar/viva-voce presentation before the examiners' board.
Seminar / Capstone Project (Pitch Deck / Startup / Innovation) – VII Semester
Marks Distribution: CA – 50, MTE – 50, ETE – 100 (Total = 200 Marks)
Continuous Assessment (CA): Based on participation, interim presentations, innovation ideas, and engagement with mentor/supervisor.
Mid-Term Evaluation (MTE): Conducted by an internal evaluation board to assess progress, innovation potential, and feasibility of the capstone/startup idea.

End-Term Evaluation (ETE): Conducted by a Board of Internal and External Examiners appointed by the Dean, Faculty of Engineering & Technology, including evaluation of pitch presentation, prototype/demonstration, and viva-voce.

Guidelines:

1. Each student/team shall work on a Capstone Project, Startup Idea, or Innovation Pitch Deck under the guidance of a faculty supervisor or industry mentor.
2. A written report/pitch deck document along with a prototype (if applicable) must be submitted at least two weeks prior to the commencement of the End-Semester Examination.
3. The evaluation shall be based on:

~ Novelty and originality of the idea/concept.
~ Technical soundness, design thinking, and feasibility.
~ Practical relevance and potential for industry/startup application.
~ Clarity, presentation quality, and ability to defend the proposal.
~ Teamwork, problem-solving, and innovation demonstrated during execution.

Major Project / Professional Practical Internship-II (VIII Semester)

Marks Distribution: MTE – 200, ETE – 600 (Total = 800 Marks)

Mid-Term Evaluation (MTE): Progress review conducted by the project supervisor(s) and internal faculty board.

End-Term Evaluation (ETE): Conducted by a Board of Internal and External Examiners appointed by the Dean, based on final project report submission, seminar, and viva-voce.

Guidelines:

1. The Major Project/Internship-II shall demonstrate independent research ability, problem-solving skills, innovation, and professional application of knowledge.
2. Students are required to submit a final bound thesis/project report in the prescribed format and defend their work in a comprehensive viva-voce examination.
3. Evaluation parameters include:

~ Originality and significance of the work undertaken.
~ Technical depth, methodology, and results achieved.
~ Quality of documentation, adherence to academic integrity, and proper referencing.
~ Presentation skills, clarity of concepts, and ability to defend work during viva-voce.

9.1 Calculation System of Semester Grade Point Average

Computation of the Semester Grade Point Average (SGPA) and Cumulative Performance Index (CPI):

The Semester Grade Point Average (SGPA) shall serve as the formal indicator of a student's overall academic performance in all courses registered during a given semester. The computation of SGPA shall be carried out in accordance with the grading system prescribed by the University. If the grades awarded to a student in various courses are denoted as G_1, G_2, ... , Gn and the corresponding credits are denoted as C_1, C_2, ... , Cn, then the SGPA shall be determined by the formula:

$$GPA = \frac{C_1 \times G_1 + C_2 \times G_2 + \cdots + C_n \times G_n}{C_1 + C_2 + \cdots + C_n}$$

The Cumulative Performance Index (CPI) shall reflect the overall academic performance of a student across all courses registered up to and including the most recently completed semester or summer term. The computation of the CPI shall follow the same methodology as that of the SGPA, but shall encompass the aggregate of all courses undertaken (denoted as n). Accordingly, the CPI is expressed as:

$$CPI = \frac{\sum_{i=1}^{n} C_i \times G_i}{\sum_{i=1}^{n} C_i}$$

Percentage conversion of CPI:

$$\textbf{Percentage of marks} = ((\textbf{SGPA/CGPA}) \times \mathbf{10}) - \mathbf{4.5}$$

The minimum passing marks shall be as prescribed under the applicable Acts, Statutes, and Ordinances of Rama University.

9.2 Minimum Academic Requirements and CPI Conversion:

To be declared successful in a given semester, a student shall be required to secure at least a minimum grade of 'E' in each subject and attain a Cumulative Performance Index (CPI) of not less than 5.0.

The classification of results on the basis of CPI shall be as follows:

- **CPI ≥ 8.0**: First Division with Honours
- **CPI ≥ 6.0 but < 8.0**: First Division
- **CPI ≥ 5.0 but < 6.0**: Second Division
- **CPI < 5.0**: Fail

9.3 Calculation of Grade Point and Grade Point Average

Relative Grading shall be applicable in the Faculty of Engineering & Technology, Rama University. The system of letter grades and the corresponding grade points shall be as under:

Letter Grade	Performance	Grade Points
O	Outstanding	10
A	Excellent	9
B	Very Good	8
C	Good	7
D	Average	6
E	Pass	5
F	Fail	0
AB	Absent	-

Letter Grade	Performance	Grade Points
AB	Absent	-
Q	Qualified	-
NQ	Not Qualified	-

10. Rules for Backlogs / Supplementary Exams

A student failing in one or more courses shall be eligible to appear in supplementary examinations conducted by the University as per the notified schedule and prevailing rules. The number of permissible backlogs for promotion shall be governed by University promotion regulations. Students failing to clear such backlogs within the maximum duration of the program shall not be awarded the degree. Supplementary examinations may be attempted within the limit of attempts prescribed under University norms. Improvement examinations are permitted only for theory papers already passed, subject to approval of the Examination Cell and applicable University rules.

11. Special Academic Requirements

In addition to the prescribed regular coursework, every student of the B.Tech (Computer Science and Engineering with specialization in Internet of Things (IoT))programme shall be required to complete all courses and activities as specified in the approved schema/syllabus. The programme also mandates participation in project-based learning, innovation-driven activities, and professional development components aimed at enhancing practical skills, industry exposure, and entrepreneurial mindset.

Students shall be required to undertake a Seminar/Capstone Project (Pitch Deck on Startup/Innovation/Research Problem) in the seventh semester. They must also participate in a minimum of two industrial/research lab visits during the programme to gain real-world exposure and professional orientation.

During the seventh semester, students shall engage in a Minor Project / Professional Practical Internship-I, under the guidance of an appointed supervisor/mentor.

In the eighth semester, students shall pursue a Major Project / Professional Practical Internship-II of six months, preferably in collaboration with industries, research laboratories, or academic institutions. Students must present their work through a comprehensive seminar and viva voce examination, which shall form an integral part of the evaluation framework.

This structure ensures that students acquire a balanced blend of academic knowledge, applied learning, research exposure, and professional competencies, in alignment with the vision of NEP-2020, UGC, and AICTE guidelines.

12. Other Provisions

12.1 Attendance: Students must maintain a minimum of 75% attendance in every course to be eligible for appearing in examinations. Condonation may be granted in exceptional cases, as per University rules.

12.2 Discipline: Students must adhere to the code of conduct, anti-ragging policies, academic integrity rules, and ethical guidelines laid down by the University.

12.3 Use of Technology: Students are encouraged to complete online certification courses (MOOCs/NPTEL/SWAYAM) to earn credits.

12.4 Plagiarism and Malpractice: Strict action will be taken against students found guilty of unfair practices in examinations, assignments, or project work.

12.5 Change of Program: The change of branch shall be governed strictly in accordance with the prevailing University norms and the provisions contained in the previously applicable ordinances.

12.6 Teaching: Teaching shall be conducted strictly in accordance with the prevailing University norms and in conformity with the provisions of the previously applicable ordinance."

12.7 Examination: Examinations shall be held strictly in accordance with the prevailing University norms and in conformity with the provisions of the previously applicable ordinance.

12.8 Evaluation Feedback: The process of evaluation and feedback shall be regulated in accordance with the established University norms and subject to the stipulations of the earlier ordinance.

12.9 Promotion: Promotion of students shall be determined in pursuance of the University norms and in accordance with the directives contained in the preceding ordinance.

12.10 Carryover: Carryover of courses shall be administered in alignment with the University norms and in consonance with the provisions laid down in the earlier ordinance.

12.11 Ex-Studentship and Re-Admission: Matters pertaining to ex-studentship and re-admission shall be governed in accordance with the University norms and subject to the provisions embodied in the prior ordinance.

13. Exit Options (NEP-2020)

In accordance with NEP-2020 guidelines, the programme provides multiple exit options:

- After 1 year (2 semesters): **Certificate in respective specialization**
- After 2 years (4 semesters): **Diploma in respective specialization**
- After 3 years (6 semesters): **Advanced Diploma in respective specialization**

- After 4 years (8 semesters): **B. Tech Degree in respective specialization**

Students opting for exit must fulfill credit requirements and apply formally to the University.

Conclusion

This Ordinance shall come into effect from the academic session 2025-26 and shall be applicable to all new admissions henceforth. The University reserves the right to amend, modify, or update the Ordinance as and when required, subject to approval by statutory bodies. Any interpretation of these regulations shall rest with the Academic Council of Rama University.

Rama University, Uttar Pradesh Kanpur

Faculty of Engineering and Technology

B.Tech (CSE/AIML/DS/IoT/CC)

I SEM

S No	Course Category	Course Code	Course Name	L	T	P	CREDITS	CA	MTE	ETE	TOTAL MARKS
1	BSC	BCN1001	Mathematics-I	3	1	0	4	30	20	50	100
2	ESC	BCN1002	Electrical and Electronics Engineering	3	0	0	3	30	20	50	100
3	BSC	BCN1003/BCN2007	Physics	3	0	0	3	30	20	50	100
4	ESC	BCN1004	Problem Solving using Programming	3	0	0	3	30	20	50	100
5	ESC	BCN1005/BCN2008	Mechanical Engineering and Robotics	3	0	0	3	30	20	50	100
6	ESC	BCN1052	Electrical and Electronics Engineering Lab	0	0	2	1	30	20	50	100
7	BSC	BCN1053/2057	Physics Lab	0	0	2	1	30	20	50	100
8	ESC	BCN1054	Problem Solving using Programming Lab	0	0	2	1	30	20	50	100
9	ESC	BCN1055/BCN2058	Workshop/Manufacturing Practices Lab	0	0	2	1	30	20	50	100
			Total	**15**	**1**	**8**	20				**900**

II SEM

S No	Course Category	Course Code	Course Name	L	T	P	CREDITS	CA	MTE	ETE	TOTAL MARKS
1	BSC	BCN2001	Mathematics-II	3	1	0	4	30	20	50	100
2	BSC	BCN2002/1007	Chemistry	3	0	0	3	30	20	50	100
3	PCC	BCS2003	Object Oriented Programming	3	0	0	3	30	20	50	100
4	HSC	BCN2004/1008	Life Skills: Entrepreneurship, Language, Communication and Personality	3	0	0	3	30	20	50	100
6	MC	BCN2005	Universal Human Values-II: Understanding Harmony And Ethical Human Conduct	2	1	0	3	30	20	50	100
11	AUC	BCN2006	Hobbies, Co-Curricular and Extra-Curricular	2	0	0	0	30	20	50	100
7	BSC	BCN2052/1057	Chemistry Lab	0	0	2	1	30	20	50	100
8	PCC	BCS2053	Object Oriented Programming Lab	0	0	2	1	30	20	50	100
9	HSC	BCN2054/1058	Life Skills: Entrepreneurship, Language, Communication and Personality Lab	0	0	2	1	30	20	50	100
10	ESC	BCN2059	Design thinking and innovation Lab	0	0	2	1	30	20	50	100
			Total	**16**	**2**	**8**	20				**1000**

III SEM

S No	Course Category	Course Code	Course Name	L	T	P	CREDITS	CA	MTE	ETE	TOTAL MARKS
1	PCC	BCS3001	Mathematics-III	3	1	0	4	30	20	50	100
2	PCC	BCS3002	Operating Systems	3	0	0	3	30	20	50	100
3	PCC	BCS3003	Information Management System	3	0	0	3	30	20	50	100
4	PCC	BCS3101 - 3107/ BCS3006	Specialization Core-I/ UI UX Design	3	0	0	3	30	20	50	100
5	PCC	BCS3004	Data Structures and Algorithms	3	0	0	3	30	20	50	100
6	PCC	BCS3005	AI and Machine Learning	2	0	0	2	30	20	50	100
7	PCC	BCS3052	Computer Organization and Architecture Lab	0	0	2	1	30	20	50	100
8	PCC	BCS3053	Information Management System Lab	0	0	2	1	30	20	50	100
9	PCC	BCS3151 - 3157/ BCS3056	Specialization Core-I/ UI UX Design Lab	0	0	2	1	30	20	50	100
10	PCC	BCS3054	Data Structures and Algorithms Lab	0	0	2	1	30	20	50	100

11	PCC	BCS3055	AI and Machine Learning Lab	0	0	2	1	30	20	50	100
12	MC	BCN3007	Humanities-I	2	0	0	2	30	20	50	100
			Total	**19**	**1**	**10**	**25**				**1200**
IV SEM											
S No	**Course Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**CREDITS**	**CA**	**MTE**	**ETE**	**TOTAL MARKS**
1	PCC	BCS4001	Computer Networks	3	0	0	3	30	20	50	100
2	PCC	BCS4002	Discrete Mathematics	3	1	0	4	30	20	50	100
3	PCC	BCS4101-4106/ BCS4006	Specialization Core-II/ Full Stack and Web Development	3	0	0	3	30	20	50	100
4	PCC	BCS4003	Software Engineering and System Design	2	0	0	2	30	20	50	100
5	PCC	BCS4004	Cloud Infrastructure and Services	2	0	0	2	30	20	50	100
6	PCC	BCS4005	Computer Organization and Architecture	3	0	0	3	30	20	50	100
7	PCC	BCS4051	Computer Networks Lab	0	0	2	1	30	20	50	100
8	PCC	BCS4151-4156/ BCS4056	Specialization Core-II/ Full Stack and Web Development Lab	0	0	2	1	30	20	50	100
9	PCC	BCS4052	Software Engineering and System Design Lab	0	0	2	1	30	20	50	100
10	PCC	BCS4053	Cloud Infrastructure and Services Lab	0	0	4	2	30	20	50	100
11	PCC	BCS4054	Operating Systems Lab	0	0	2	1	30	20	50	100
12	MC	BCN4007	Environmental Sciences	3	0	0	0	30	20	50	100
			Total	**19**	**1**	**12**	**23**				**1200**
V SEM											
S No	**Course Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**CREDITS**	**CA**	**MTE**	**ETE**	**TOTAL MARKS**
1	PCC	BCS5001	Design and Analysis of Algorithms	3	1	0	4	30	20	50	100
2	PCC	BCS5002	Deep Learning	3	0	0	3	30	20	50	100
3	PCC/PEC	BCSS201-246/ BCSP301-325	Specialization Elective-I/ Professional Elective I	3	0	0	3	30	20	50	100
4	PCC	BCS5003	AI Assisted Coding and Data Analytics	1	0	0	1	30	20	50	100
5	PCC	BCS5004	Cyber Security	3	0	0	3	30	20	50	100
6	PCC	BCS5005	Theory of Computation	3	0	0	3	30	20	50	100
7	PCC	BCS5051	Design and Analysis of Algorithms Lab	0	0	4	2	30	20	50	100
8	PCC	BCS5052	Deep Learning Lab	0	0	2	1	30	20	50	100
9	PCC	BCS5053	AI Assisted Coding and Data Analytics Lab	0	0	4	2	30	20	50	100
10	PCC	BCS5056	Undergraduate Research in Computer Science	0	0	2	1	30	20	50	100
11	MC	BCN5007	Essence of Indian Knowledge Tradition	0	0	0	0	30	20	50	100
			Total	**16**	**1**	**12**	**23**				**1100**
VI SEM											
S No	**Course Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**CREDITS**	**CA**	**MTE**	**ETE**	**TOTAL MARKS**
1	PCC	BCS6001	High Performance Computing	3	0	0	3	30	20	50	100
2	PCC/PEC	BCSS201-246/ BCSP301-325	Specialization Elective - II / Professional Elective - II	3	0	0	3	30	20	50	100
3	PCC	BCS6003	Competitive Programming	3	0	0	3	30	20	50	100
4	PCC	BCS6004	Compiler Design	3	0	0	3	30	20	50	100
5	BSC	BCS6005	Quantitative Aptitude and Logical Reasoning	2	0	0	2	30	20	50	100
6	OEC	BCSO401 - 422	Open Elective-I	3	0	0	3	30	20	50	100
7	PCC	BCS6051	High Performance Computing Lab	0	0	2	1	30	20	50	100
8	PCC	BCS6053	Competitive Programming Lab	0	0	4	2	30	20	50	100

			Total	**17**	**0**	**6**	**20**				**800**
11	PCC	BCS6006	**Summer Internship/ Field Work (Minimum 8 weeks)***				**1**	**50**		**50**	**100**
		*** This credit will be reflected in VII semester result.**									
VII SEM											
S No	**Course Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**CREDITS**	**CA**	**MTE**	**ETE**	**TOTAL MARKS**
1	PCC/PEC	BCSS201-246/ BCSP301-325	Specialization Elective - III / Professional Elective-III	3	0	0	3	30	20	50	100
2	OEC	BCSO401 - 422	Open Elective-II	3	0	0	3	30	20	50	100
3	PEC	BCSP301-325	Professional Elective-IV	3	0	0	3	30	20	50	100
4	PRC	BCS7051	Capstone Project with Design Thinking	0	0	12	6	30	20	50	100
			Total	**9**	**0**	**12**	**15**				**500**
			or								
1	OEC	BCSO401 - 422	Open Elective-II	3	0	0	3	30	20	50	100
2	PRC	BCS7052	Industrial Project/R&D Project/Industry Internship/Start-up/Externship	0	0	24	12	-	100	200	300
			Total	**3**	**0**	**24**	**15**				**500**
VIII SEM											
S No	**Course Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**CREDITS**	**CA**	**MTE**	**ETE**	**TOTAL MARKS**
1	OEC	BCSO401 - 422	Open Elective-III	3	0	0	3	30	20	50	100
2	PRC	BCS8051	Major Project/Industrial Project/R&D Project/Industry Internship/Start-up/Externship	0	0	24	**12**	-	100	200	300
			Total	3	0	24	**15**				**400**

Specialization Core I								
S. No.	**Course Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credit**	**Category**
1	PCC	BCS3101	Statistical Machine Learning	3	0	0	3	**AI-Core I**
3	PCC	BCS3102	Data Analysis using Python	3	0	0	3	**DS Core-I**
5	PCC	BCS3103	Cloud Computing	3	0	0	3	**CC Core-I**
9	PCC	BCS3105	Linux and Shell Programming	3	0	0	3	**Cyber Security Core-I**
11	PCC	BCS3106	Microcontrollers, Robotics & Embedded Systems	3	0	0	3	**IoT Core-I**
14	PCC	BCS3151	Statistical Machine Learning Lab	0	0	2	1	**AI-Core I**
16	PCC	BCS3152	Data Analysis using Python Lab	0	0	2	1	**DS Core-I**
18	PCC	BCS3153	Cloud Computing Lab	0	0	2	1	**CC Core-I**
22	PCC	BCS3155	Linux and Shell Programming Lab	0	0	2	1	**Cyber Security Core-I**
24	PCC	BCS3156	Microcontrollers, Robotics & Embedded Systems Lab	0	0	2	1	**IoT Core-I**

Specialization Core II								
S. No.	**Course Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credit**	**Category**
1	PCC	BCS4101	Intelligent Model Design using AI	3	0	0	3	**AI Core-II**
2	PCC	BCS4102	Data Mining and Predictive Modelling	3	0	0	3	**DS Core-II**
3	PCC	BCS3104	DevOps Practices and Principles	3	0	0	3	**CC Core II**
4	PCC	BCS4103	Programming Methodologies for Backend Development	3	0	0	3	**CC Core II**
5	PCC	BCS4104	Design of Cloud Architectural Solutions	3	0	0	3	**CC Core-II**
6	PCC	BCS4105	System and Network Security	3	0	0	3	**Cyber Security Core-II**
7	PCC	BCS3107	IoT Networks and Protocols	3	0	0	3	**IoT Core-II**

8	PCC	BCS4106	Robotics: Dynamics and Controls	3	0	0	3	IoT Core-II
9	PCC	BCS4151	Intelligent Model Design using AI Lab	0	0	2	1	AI Core-II
10	PCC	BCS4152	Data Mining and Predictive Modelling Lab	0	0	2	1	DS Core-II
11	PCC	BCS3154	DevOps Practices and Principles Lab	0	0	2	1	CC Core II
12	PCC	BCS4153	Programming Methodologies for Backend Development Lab	0	0	2	1	CC Core II
13	PCC	BCS4154	Design of Cloud Architectural Solutions Lab	0	0	2	1	CC Core-II
14	PCC	BCS4155	System and Network Security Lab	0	0	2	1	Cyber Security Core-II
15	PCC	BCS3157	IoT Networks and Protocols Lab	0	0	2	1	IoT Core-II
16	PCC	BCS4156	Robotics: Dynamics and Controls Lab	0	0	2	1	IoT Core-II
Specialization Electives I : Artificial Intelligence								
S. No.	Course Category	Course Code	Course Name	L	T	P	Credit	
1	SEC	BCSS201	Advanced Computer Vision and Video Analytics	3	0	0	3	
2	SEC	BCSS202	Cognitive Modelling	3	0	0	3	
3	SEC	BCSS203	Probability and Random Processes	3	0	0	3	
Specialization Electives II : Artificial Intelligence								
S. No.	Course Category	Course Code	Course Name	L	T	P	Credit	
1	SEC	BCSS204	AI in Healthcare	3	0	0	3	
2	SEC	BCSS205	Image and Video Processing	3	0	0	3	
3	SEC	BCSS206	Information Retrieval and Search Engine	3	0	0	3	
4	SEC	BCSS207	Natural Language Processing	3	0	0	3	
Specialization Electives III : Artificial Intelligence								
S. No.	Course Category	Course Code	Course Name	L	T	P	Credit	
1	SEC	BCSS208	Social Network Analysis	3	0	0	3	
2	SEC	BCSS209	Reinforcement Learning	3	0	0	3	
3	SEC	BCSS210	Emerging Topics in Artificial Intelligence	3	0	0	3	
Specialization Electives I: Data Science								
S. No.	Course Category	Course Code	Course Name	L	T	P	Credit	
1	SEC	BCSS211	Digital Marketing and Trend Analysis	3	0	0	3	
2	SEC	BCSS212	Structural Equation Modelling	3	0	0	3	
3	SEC	BCSS213	Time Series Analysis	3	0	0	3	
Specialization Electives II : Data Science								
S. No.	Course Category	Course Code	Course Name	L	T	P	Credit	
1	SEC	BCSS214	Data Visualization and Dashboards	3	0	0	3	
2	SEC	BCSS215	Security and Privacy for Big Data Analytics	3	0	0	3	
3	SEC	BCSS216	Big Data Analytics and Business Intelligence	3	0	0	3	
Specialization Electives III: Data Science								
S. No.	Course Category	Course Code	Course Name	L	T	P	Credit	
1	SEC	BCSS217	Advanced Database Management System	3	0	0	3	
2	SEC	BCSS218	Satellite Data Analysis	3	0	0	3	
3	SEC	BCSS219	Emerging Topics in Data Science	3	0	0	3	

Specialization Electives I : IoT and Robotics							
S. No.	Course Category	Course Code	Course Name	L	T	P	Credit
1	SEC	BCSS220	IoT Analytics	3	0	0	3
2	SEC	BCSS221	IoT: Security and Attacks	3	0	0	3
Specialization Electives II : IoT and Robotics							
S. No.	Course Category	Course Code	Course Name	L	T	P	Credit
1	SEC	BCSS222	Device Level IoT Security	3	0	0	3
2	SEC	BCSS223	Humanoids	3	0	0	3
Specialization Electives III : IoT and Robotics							
S. No.	Course Category	Course Code	Course Name	L	T	P	Credit
1	SEC	BCSS224	Mobile IoT Networks	3	0	0	3
2	SEC	BCSS225	Emerging Topics in IoT and Robotics	3	0	0	3
Specialization Electives I: Cloud Computing and DevOps							
S. No.	Course Category	Course Code	Course Name	L	T	P	Credit
1	SEC	BCSS226	Cloud System Administration and Operations	3	0	0	3
2	SEC	BCSS227	Cloud Security and Compliances	3	0	0	3
3	SEC	BCSS228	AWS Cloud Support Associate	3	0	0	3
4	SEC	BCSS229	Developing Solutions for Microsoft Azure	3	0	0	3
Specialization Electives II: Cloud Computing and DevOps							
S. No.	Course Category	Course Code	Course Name	L	T	P	Credit
1	SEC	BCSS230	Google Associate Cloud Engineer	3	0	0	3
2	SEC	BCSS231	Software Containerization in DevOps	3	0	0	3
3	SEC	BCSS232	Build and Release Management in DevOps	3	0	0	3
4	SEC	BCSS233	Cloud Services Development and Operations	3	0	0	3
5	SEC	BCSS234	Source and Version Control in DevOps	3	0	0	3
Specialization Electives III: Cloud Computing and DevOps							
S. No.	Course Category	Course Code	Course Name	L	T	P	Credit
1	SEC	BCSS235	Continuous Integration and Deployment in DevOps	3	0	0	3
2	SEC	BCSS236	Software Craftsmanship in DevOps	3	0	0	3
3	SEC	BCSS237	System Provisioning and Configuration Management in DevOps	3	0	0	3
4	SEC	BCSS238	Test Automation in DevOps	3	0	0	3
Specialization Electives I: Cyber Security							
S. No.	Course Category	Course Code	Course Name	L	T	P	Credit
1	SEC	BCSS239	Cyber Security with Blockchain	3	0	0	3
2	SEC	BCSS240	Malware Analysis for Mobile Devices	3	0	0	3
3	SEC	BCSS241	Modern Cryptography	3	0	0	3
Specialization Electives II: Cyber Security							

S. No.	Course Category	Course Code	Course Name	L	T	P	Credit
1	SEC	BCSS242	Vulnerability Analysis in Network Protocols	3	0	0	3
2	SEC	BCSS243	Penetration Testing, Auditing and Ethical Hacking	3	0	0	3

Specialization Electives III: Cyber Security

S. No.	Course Category	Course Code	Course Name	L	T	P	Credit
1	SEC	BCSS244	Forensics and Cyber Law	3	0	0	3
2	SEC	BCSS245	Web Security	3	0	0	3
3	SEC	BCSS246	Emerging Topics in Cyber Security	3	0	0	3

Professional Elective I

S. No.	Course Category	Course Code	Course Name	L	T	P	Credit
1	PEC	BCSP301	Human Computer Interaction	3	0	0	3
2	PEC	BCSP302	Blockchain Engineering	3	0	0	3
3	PEC	BCSP303	Quantum Computing	3	0	0	3
4	PEC	BCSP304	Augmented and Virtual Reality	3	0	0	3
5	PEC	BCSP305	Data Center Operations and Infrastructure	3	0	0	3
6	PEC	BCSP306	DevOps and Full Stack	3	0	0	3
7	PEC	BCSP307	Game Mechanics, Design and Development	3	0	0	3
8	PEC	BCSP308	Java Programming	3	0	0	3

Professional Elective II

S. No.	Course Category	Course Code	Course Name	L	T	P	Credit
1	PEC	BCSP309	Security Ethics and Regulations in AI	3	0	0	3
2	PEC	BCSP310	Game Engine and Architecture	3	0	0	3
3	PEC	BCSP311	Machine Learning with Quantum Computing	3	0	0	3
4	PEC	BCSP312	Generative AI	3	0	0	3
5	PEC	BCSP313	Drone Remote Sensing	3	0	0	3
6	PEC	BCSP314	Digital Bots Development	3	0	0	3
7	PEC	BCSP315	VR and 360 Video Production	3	0	0	3
8	PEC	BCSP316	Product Design Architecture and Delivery	3	0	0	3

Professional Elective III

S. No.	Course Category	Course Code	Course Name	L	T	P	Credit
1	PEC	BCSP317	Advance Swift Programming	3	0	0	3
2	PEC	BCSP318	VR Gaming	3	0	0	3
3	PEC	BCSP319	Augmented Reality	3	0	0	3
4	PEC	BCSP320	Game Mechanics and Game Physics	3	0	0	3
5	PEC	BCSP321	Game Programming with HTML5	3	0	0	3
6	PEC	BCSP322	AI for Games	3	0	0	3
7	PEC	BCSP323	Animation and Rendering Techniques	3	0	0	3

Open Elective I

S. No.	Course Category	Course Code	Course Name	L	T	P	Credit
1	OEC	BCSO401	Applications of AI	3	0	0	3
2	OEC	BCSO402	Web Technologies	3	0	0	3

3	OEC	BCS0403	Semantic Technology	3	0	0	3
4	OEC	BCS0404	IT Support Technologies	3	0	0	3
5	OEC	BCS0405	Software Engineering	3	0	0	3
6	OEC	BCS0406	Programming Languages	3	0	0	3
7	OEC	BCS0407	Artificial Intelligence for Creative Expression	3	0	0	3

Open Elective II

S. No.	Course Category	Course Code	Course Name	L	T	P	Credit
1	OEC	BCS0408	AI and Public Policy	3	0	0	3
2	OEC	BCS0409	Linux Apache MySQL PHP (LAMP)	3	0	0	3
3	OEC	BCS0410	Software Testing	3	0	0	3
4	OEC	BCS0411	Computing Start-ups	3	0	0	3
5	OEC	BCS0412	Career Skills for IT Companies	3	0	0	3
6	OEC	BCS0413	Cyber security: Impact on Govts, Policies and Economics	3	0	0	3
7	OEC	BCS0414	AI and Society	3	0	0	3

Open Elective III

S. No.	Course Category	Course Code	Course Name	L	T	P	Credit
1	OEC	BCS0415	Special Topics in Computer Engineering	3	0	0	3
2	OEC	BCS0416	Search Engine Optimization	3	0	0	3
3	OEC	BCS0417	Growth Hacking	3	0	0	3
4	OEC	BCS0418	Digital Marketing	3	0	0	3
5	OEC	BCS0419	Advanced Skill Enhancement	3	0	0	3
6	OEC	BCS0420	Advanced Industry Certification	3	0	0	3
7	OEC	BCS0421	Global Experience and Practicum	3	0	0	3
8	OEC	BCS0422	International Acquaintance and Externship	3	0	0	3

Terminology and Abbreviation

L-T-P: Lecture-Tutorial-Practical hours per week.

Credits: Calculated as per AICTE norms (1 credit per lecture/tutorial hour, 0.5 credits per practical hour).

HSC: Humanities and Social Sciences including Management Courses

BSC: Basic Science Courses

ESC: Engineering Science Courses

PCC:

PEC: Professional Elective Courses

OEC: Open Elective Courses

PRC: Project Work, Seminar, Internship Courses

MC: Mandatory Courses

AUC: Audit Cources

BCSS: Computer Science Specialization Elective

BCSP: Computer Science Professional Elective

BCSO: Computer Science Open Elective

MOOC: As per page no 191 of AICTE Model Curriculum for UG Degree Course 2022

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Bachelor of Technology (BTech): Syllabus

Computer Science & Engineering

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Semester-I

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCN1001	Mathematics-I	L	T	P	C
Owning School/Department	FET	3	1	0	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Solving system of linear equations by using Gaussian elimination to reduce the augmented matrix to row echelon form or to reduced row echelon form.
CO2: To be familiar with the concepts of dimension of a subspace and the rank and nullity of a matrix.
CO3: To calculate the eigenvalues and eigenvectors of a square matrix using the characteristic polynomial.

Course Contents:

UNIT 1: **08 lecture hours**

Curvature, evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.

UNIT 2: **06 lecture hours**

Rolle's Theorem, Mean value theorems and applications; Extreme values of functions; Linear approximation; Indeterminate forms and L' Hospital's rule.

UNIT 3: **10 lectures hours**

Limits of sequence of numbers, Calculation of limits, Infinite series; Tests for convergence; Power series, Taylor and Maclaurin series; Taylor theorem, convergence of Taylor series, error estimates.

UNIT 4: **08 lectures hours**

Limit, continuity and partial derivatives, directional derivatives, gradient, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers.

UNIT 5: **10 lectures hours**

Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Gradient, curl and divergence, Theorems of Green, Gauss and Stokes.

Text Books :

1. Strang, Gilbert. *Introduction to linear algebra.* 4th ed. Wellesley-Cambridge Press, 2006. ISBN 978- 0030105678.
2. Kreyszig, Erwin. *Advanced Engineering Mathematics 10th Edition with Wiley Plus Set.* John Wiley & Sons, 2010. ISBN 978-0470458365.

Reference Books :

1. Hoffmann, Kenneth, and Ray Alden Kunze. *Linear algebra*. 2nd ed. Prentice-Hall, 2004. ISBN 9789332550070.
2. Simmons, George F. *Differential equations with applications and historical notes*. 2nd ed. McGraw-Hill Education (India) Pvt Limited, 2002. ISBN 978-0070530713.
3. Coddington, Earl A. *An introduction to ordinary differential equations*. 1st ed. DoverPublication, 1989. ISBN 9780486659428.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCN1002/ BCN1052	Electrical and Electronics Engineering	L	T	P	C
Owning School/Department	FET	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate the fundamental parameters governing an electrical circuit such as current, voltage.
CO2: To explain basic electronic components such as resistors, capacitors, and inductors.
CO3: To make use of concepts, working, and application of various circuits using the components on a breadboard.

Course Contents:

UNIT 1: **12 lecture hours**

Electronics: Semiconductor Fundamentals, Diodes: Characteristics and Applications in Digital Circuits, Transistors - BJTs and MOSFETs as Switches, Logic Gates using Diodes and Transistors, Digital Systems and Binary Representation, Number Systems and conversion, Boolean Algebra and Logic Gates, Combinational Logic Design: Truth Tables and Boolean Expressions, Combinational Logic Design: Karnaugh Maps and Simplification, Multiplexers, Decoders, and Encoders, Adders and Subtractors, Sequential Logic Design: Flip-Flops - SR, JK, Sequential Logic Design: D and T Flip-Flops, Registers, Counters

UNIT 2: **10 lecture hours**

Sensors and Transducers, Common Types of Sensors - Temperature, Light, Common Types of Sensors - Motion, Pressure, Actuators - Motors, Relays, Interfacing Sensors and Actuators,Power Electronics: Voltage Regulation, Power Electronics: DC-DC Converters, Analog-to-Digital Conversion -ADC, Digital-to-Analog Conversion -DAC, Microcontrollers - Architecture

UNIT 3: **08 lecture hours**

Circuit Elements and Ohm's Law, Kirchhoff's Current Law -KCL, Kirchhoff's Voltage Law -KVL, Series and Parallel Resistor Combinations

UNIT 4: **06 lecture hours**

Single-Phase AC Circuits, Circuit Elements in AC, Impedance and Admittance, Phasor Representation and Power

UNIT 5: **06 lecture hours**

Principles of Operation, Relevance in Computing Systems, Electrical Machines Applications

Laboratory:

1. Diode Characteristics and Applications in Simple Circuits
2. Transistor as a Switch: Experimental Verification
3. Implementation of Logic Gates using Transistors
4. Verification of Boolean Algebra and Truth Tables using Logic Gates
5. Design and Implementation of Combinational Logic Circuits
6. Implementation and Testing of Sequential Logic Circuits: Flip-Flops and Counters
7. Verification of Kirchhoff's Laws in DC Circuits
8. Analysis of Series and Parallel Resistor Circuits

9. Measurement of Voltage, Current, and Impedance in AC Circuits
10. Sensor Characteristics and Interfacing
11. Interfacing and Controlling Simple Actuators
12. Microcontroller Programming and I/O Operations

Text Books:

1. Charles, K. Alexander, and N. O. Matthew. *Fundamentals of electric circuits*. 1st ed. McGraw-hill Education, 2017. ISBN 9789353165505.
2. Boylestad, Robert L., and Louis Nashelsky. *Electronic devices and circuit theory*. 1st ed. Pearson Education India, 2009. ISBN 9788131703144.
3. Tsividis, Yannis. *A First Lab in Circuits and Electronics*. 1st ed. Wiley, 2002. ISBN 9780471386957.

Reference Books :

1. Neamen, Donald A. *Microelectronics: circuit analysis and design*. 1st ed. New York: McGraw-Hill, 2009. ISBN 978-0073380643.
2. Bell, David A. *Electronic instrumentation and measurements*. 3rd ed. Oxford University Press India, 2013. ISBN 978-0195696141.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCN1003/2007/ BCN1053/2057	Physics	L	T	P	C
Owning School/Department	FET	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Apply relativistic principles to solve basic physical problems.
CO2: Apply quantum physics principles to solve basic physical problems.
CO3: Analyze and use Maxwell's equations in modelling EM systems.
CO4: Describe and utilize wave optics for imaging and diagnostics.
CO5: Understand lasers and fiber optics for sensing and data transmission.

Course Contents:

UNIT 1: **08 lecture hours**

Inertial and non-inertial frames, Galilean vs Lorentz transformations, Postulates of Special Relativity, Time dilation, length contraction, Relativistic momentum and energy, Mass-energy equivalence: equivalence: $E=mc2$

UNIT 2: **10 lecture hours**

Limitations of classical physics, de-Broglie hypothesis; Davisson-Germer experiment, Phase and group velocity, Schrödinger equation (time-dependent and time-independent), Wave function interpretation; particle in a dimensional box

UNIT 3: **08 lecture hours**

Continuity equation, displacement current, Maxwell's equations (differential & integral forms), Electromagnetic waves in vacuum and conductors; Poynting vector, Skin depth

UNIT 4: **08 lecture hours**

Coherent sources, interference (thin films, Newton's rings), Diffraction: single slit, double slit, diffraction grating, Absent spectra, dispersive and resolving power

UNIT5: **08 lecture hours**

Total internal reflection, Step-index vs graded-index fibers, Numerical aperture, attenuation, dispersion, Applications in sensors, Spontaneous and stimulated emission, He-Ne and Ruby lasers, Laser applications

Laboratory:

Group A

1. To determine the wavelength of sodium light by Newton's ring experiment.
2. To determine the wavelength of different spectral lines of mercury light using plane transmission grating.
3. To determine the specific rotation of cane sugar solution using polar-meter.
4. To determine the focal length of the combination of two lenses separated by a distance and verify the formula for the Focal length of combination of lenses.

5. To measure attenuation in an optical fiber.
6. To determine the wavelength of He-Ne laser light using single slit diffraction.
7. To study the polarization of light using He-Ne laser light.
8. To determine the wavelength of sodium light with the help of Fresnel's bi-prism.
9. To determine the coefficient of viscosity of a given liquid.
10. To determine the value of acceleration due to gravity (g) using compound pendulum.

Group B
1. To determine the energy band gap of a given semiconductor material.
2. To study Hall effect and determine Hall coefficient, carrier density and mobility of a given semiconductor Material using Hall Effect setup.
3. To determine the variation of magnetic field with the distance along the axis of a current carrying coil and Estimate the radius of the coil.
4. To verify Stefan's law by electric method.
5. To determine resistance per unit length and specific resistance of a given resistance using Carey Fosters Bridge.
6. To study the resonance condition of a series LCR circuit.
7. To determine the electrochemical equivalent (ECE) of copper.
8. To calibrate the given ammeter and voltmeter by potentiometer.
9. To draw hysteresis (B-H curve) of a specimen in the form of a transformer and to determine its Hysteresis loss.
10. To measure high resistance by leakage method.

TextBooks :

1.Practical Physics- K. K. Dey& B. N. Dutta (Kalyani Publishers New Delhi)
2.Engineering Physics-Theory and Practical- Katiyar& Pandey (Wiley India)
3.Engineering Physics Practical- S K Gupta (KrishnaPrakashan Meerut)

Text Books

1. Concepts of Modern Physics – Arthur Beiser
2. Introduction to Electrodynamics – David J. Griffiths
3.Optics – Ajoy Ghatak Engineering Physics – D.C. Tayal

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCN1004/BCN1054	Problem Solving using Programming	L	T	P	C
Owning School/Department	FET	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Understand and Apply Fundamental Computer Science Concepts
CO2: Develop Proficiency in Python Programming Basics.
CO3: Implement Advanced Python Constructs and Data Structures.

Course Contents:

UNIT 1: **12 lecture hours**

Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.), Input/Output Devices, Number System, Idea of Algorithm: steps to solve logical and numerical problems. Introduction to Programming, Representation of Algorithm: Flowchart/Pseudocode with examples. From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.

UNIT 2: **08 lecture hours**

Features and Applications of Python, Setting up Python Development Environment, Keywords, Identifiers, Statements, Indentation, Comments, Variables Declaration, Assignment, Naming Conventions, Data Types: Integers, Floating-Point Numbers, Strings, Booleans. Input and Output using print- and input- functions, Numbers and Arithmetic Operators - Addition, Subtraction, Multiplication, Division, Modulus, Exponentiation, Floor Division. Operator Precedence, Comparison Operators - Equal to, Not Equal to, Greater than, Less than, Greater than or Equal to, Less than or Equal to. Logical Operators: and, or, not, Type Conversion - Implicit and Explicit Type Conversion, Bitwise Operators, Assignment Operators

UNIT 3: **10 lecture hours**

Conditional Statements - if, else, elif statements, Nested Conditional Statements, Loops: while loop. Loop Control Statements: break, continue, pass, For loop: Iterating over sequences - strings, lists, tuples for loop with range- function, Nested Loops, for-else and while-else constructs, Strings - Creating Strings, Accessing Characters, String Slicing. String Immutability, String Operations - Concatenation, Repetition. String Formatting - % operator and format- method, f-strings, Common String Methods: upper-, lower-, strip-, split-, join-, find-, replace-

UNIT 4: **12 lecture hours**

Functions - Calling Functions, Return Values, Function Parameters - Positional Arguments, Keyword Arguments, Default Arguments, Scope of Variables - Local and Global Scope, Function Composition, Recursion: Factorial, Fibonacci Sequence. Lambda Functions, UNITs, Importing UNITs - import, import as, Standard UNITs - math, random. Lists-Creating Lists, List Operations: Concatenation, Repetition, append-, insert-, remove-, pop-, index-, count-, sort-, reverse-. List Comprehension, Tuples: Creating Tuples, Tuple Operations: Concatenation, Repetition. Tuple Methods -count-, index-, Creating

Dictionaries, Common Dictionary Methods: keys-, values-, items-, get-, update-, pop-, popitem-, clear-. Dictionary Comprehension, Creating Sets, Union, Intersection, Difference, Symmetric Difference. Set Methods -add, remove, discard, update, intersection update-

Laboratory:

1. Setting up Python environment, writing and running simple Python programs.
2. Lab exercises on if, else, and elif statements.
3. Implementing while loops and using break, continue, pass statements.
4. String manipulation exercises: indexing, slicing, concatenation, and repetition.
5. Implementing programs using various string methods.
6. Lab exercises on function parameters and scope of variables.
7. Implementing recursive functions and using lambda functions.
8. Working with Lists: creating, accessing, slicing, and operations.
9. Practicing List methods and List Comprehension.
10. Working with Tuples: creating, accessing, slicing, and operations.
11. Working with Dictionaries: creating, accessing, and modifying dictionaries.
12. Practicing Dictionary methods and Dictionary Comprehension. Sets and Set operations.

Text Books:

1. *Sundarrajan M, Mani Deepak Choudhry, "Python Programming Beginners Guide", 2024.*
2. *Deepali Srivastava, "Ultimate Python Programming", BPB Online 2024.*
3. Dierbach, Charles. *Introduction to computer science using python: A computational problem-solving focus*. Wiley Publishing, 2012. ISBN 9789332584686.

Reference Books :

1. Martinez, D. and Jesús, S. D, *Applied Computational Thinking with Python: Design Algorithmic Solutions for Complex and Challenging Real-world Problems*. Packt Publishing, 2021. ISBN 89351507314.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCN1005/BCN2008	Mechanical Engineering and Robotics	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Analyze the Structure of materials at different levels, basic concepts of crystalline materials like unit cell, FCC, BCC, HCP, APF (Atomic Packing Factor), Co-ordination Number etc.
CO2: Explain the concept of phase & phase diagram & understand the basic terminologies associated with metallurgy. Construction and identification of phase diagrams and reactions
CO3: Explain features, classification, applications of newer class materials like smart materials, piezoelectric materials, biomaterials, composite materials etc.
CO4: Explain of basics of Measurements & measurement systems.
CO5: Understand the principle of limit, fits & tolerances and identify [III] the working of Limit gauges.

Course Contents:

UNIT 1: **08 lecture hours**

Classification of engineering materials, composition of cast iron and carbon steels on iron-carbon diagram and their mechanical properties, alloy steel and their applications, stress-strain diagram, Hooks law and modulus of elasticity, tensile, shear, hardness and fatigue testing of materials.

UNIT 2: **08 lecture hours**

Temperature, pressure, velocity, flow, strain, force and torque measurement, concept of measurement error & uncertainty analysis, measurement by Vernier caliper, micrometer, dial gauges, slip gauges, sine-bar and combination set, introduction to lath, drilling, milling and shaping machines, various types of carbon steels, alloy steels and cast irons, its properties and uses.

UNIT 3: **08 lecture hours**

Fluid properties, pressure, density and viscosity, pressure variation with depth, static and kinetic energy, Bernoulli's equation for incompressible fluids, viscous and turbulent flow, working principle of fluid coupling, pumps, compressors, turbines, positive displacement machines and pneumatic machines, hydraulic power & pumped storage plants for peak load management as compared to base load plants.

UNIT 4: **10 lecture hours**

First and second law of thermodynamics, steam properties, steam processes at constant pressure, volume, enthalpy & entropy, classification and working of boilers, efficiency & performance analysis, natural and induced draught, calculation of chimney height, refrigeration, vapor absorption & compression cycles, coefficient of perform (COP), refrigerant properties & ecofriendly refrigerants, working of two stroke, four stroke petrol & diesel engines, actual and hypothetical indicator diagram Steam engines.

UNIT 5: **08 lecture hours**

Introduction: Definition, Structure, Classification and Specifications of Robots, Industrial, Robot Elements and Control: Manipulators, Drives, Sensors, End Effectors, Configuration, Force/Torque

Relationship, Trajectory Planning, Position Control, Feedback System, Digital Control, Modeling of Robots: Coordinate Frames, Mapping and Transformation; Direct Kinematic Model; Inverse Kinematics; Manipulat or Differential Motion; Static Analysis; Jacobian

Text Books/Reference Books:

1. Narula; Material Science; TMH
2. Agrawal B & CM; Basic Mechanical Engg. Wiley India
3. Nag PK, Tripathi et al; Basic Mechanical Engg; TMH
4. Rajput; Basic Mechanical Engg;
5. Sawhney GS; Fundamentals of Mechanical Engg; PHI
6. Nakra and Chaudhary; Instrumentation & measurement; TMH
7. Nag PK; Engineering Thermodynamics; TMH
8. Ganesan; Combustion Engines; TMH

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCN1055/2058	Workshop/Manufacturing Practices	L	T	P	C
Owning School/Department	FET	0	0	2	2
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To provide exposure to the students with hands on experience on various basic engineering practices.
CO2: To have a study and hands-on-exercise on plumbing and carpentry components.
CO3: To have a practice on gas welding, foundry operations and fitting
CO4: To have a study on measurement of electrical quantities, energy and resistance to earth.
CO5: To have a practice on soldering.

Course Contents:

UNIT I: **02 lecture hours**

Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods.

UNIT 2: **02 lecture hours**

CNC machining, Additive manufacturing.

UNIT 3: **02 lecture hours**

Fitting operations & power tools.

UNIT 4: **02 lecture hours**

Electrical & Electronics.

UNIT 5: **01 lecture hours**

Carpentry.

UNIT 6: **02 lecture hours**

Plastic moulding, glass cutting.

UNIT 7: **01 lecture hours**

Metal casting.

UNIT 8: **02 lecture hours**

Welding (arc welding & gas welding), brazing.

Laboratory:

1. Machine shop

2. Fitting shop

3. Carpentry
4. Electrical & Electronics
5. Welding shop (Arc welding + Gas welding)
6. Casting
7. Smithy
8. Plastic moulding & Glass Cutting

Text Books/Reference Books:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
2. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.
3. Gowri P. Hariharan and A. Suresh Babu," Manufacturing Technology – I" Pearson Education, 2008.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Semester-II

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCN2001	Mathematics-II	L	T	P	C
Owning School/Department	FET	3	1	0	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Learn essential tool of matrices and linear algebra in a comprehensive manner.
CO2: Learn effective mathematical tools for the solutions of differential equations that model physical processes.

Course Contents:

UNIT 1: **10 lecture hours**

Linear Systems of Equations; Linear Independence; Rank of a Matrix; Determinant, Inverse of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Orthogonal transformation; Diagonalization of matrices; Cayley-Hamilton Theorem.

UNIT 2: **06 lecture hours**

Exact, linear and Bernoulli's equations. Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

UNIT 3: **08 lecture hours**

Second order linear differential equations with variable coefficients: Euler-Cauchy equations, solution by variation of parameters; Power series solutions: Legendre's equations and Legendre polynomials, Frobenius method, Bessel's equation and Bessel's functions of the first kind and their properties.

UNIT 4: **08 lecture hours**

Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.

UNIT 5: **10 lecture hours**

Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.

Text Books/ Reference Books:

1. AICTE's Prescribed Textbook: Mathematics-II (Calculus, Ordinary Differential Equations and Complex Variable), Khanna Book Publishing Co.
2. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
3. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edition, Wiley India, 2009.
4. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
5. S. L. Ross, Differential Equations, 3rd Edition, Wiley India, 1984.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCN2002/1007, BCN2052/1057	Chemistry	L	T	P	C
Owning School/Department	FET	3	0	2	4

Course Outcomes (COs)

CO1: To enable the students to understand the Chemistry of Atomic and Molecular structure, band structure of solids, chemistry of advanced Materials like Liquid crystals, Nanomaterials and Graphite & fullerenes.
CO2: To enable the students to understand and apply the detailed concepts of spectroscopic techniques and stereochemistry to identify the compounds, element etc.
CO3: To enable students to understand the concept of organic reactions.
CO4: To enable the students to understand and apply concepts related to Electrochemistry, Corrosion and Chemical kinetics.
CO5: To enable the students to understand and apply detailed concepts of water impurities, hardness of water, as well as analysis of coal & determination of calorific values.

Course Contents:

UNIT 1: **10 lecture hours**

Atomic and Molecular Structure: Molecular orbitals of diatomic molecules, Bond Order, Magnetic characters and numerical problems; Band structure of solids: and the role of doping on band structures; Chemistry of Advanced Materials: *Liquid Crystals;* Introduction, Types and Applications of liquid crystals, industrially important materials used as liquid crystals. *Graphite and Fullerene;* Introduction, Structure and applications, *Nanomaterials;* Introduction, Preparation, characteristics of nanomaterials and applications of nanomaterials, Carbon Nano Tubes (CNT),

UNIT 2: **08 lecture hours**

Spectroscopic Techniques and Applications: Principles of spectroscopy and selection rules. Elementary idea and simple applications of UV, IR and NMR, Numerical problems; Stereochemistry: Enantiomers, diastereomers, optical activity, absolute configurations, conformational analysis.

UNIT 3: **08 lecture hours**

Organic reactions: Introduction to reactions involving substitution, addition, elimination, cyclization and ring openings; Mechanism of Name reactions: (i) Aldol condensation (ii) Cannizzaro reaction (iii) Beckmann rearrangement. (iv) Hofmann rearrangement and (v) Diels-Alder reaction.

UNIT 4: **08 lecture hours**

Electrochemistry: Basic concepts of electrochemistry. Nernst equation and applications; Corrosion: Introduction to corrosion, Types of corrosion, Cause of corrosion, Corrosion prevention and control, Corrosion issues in specific industries (Power generation, Chemical processing industry, Oil & gas industry and Pulp & paper industries). Chemical Kinetics: Rate,

order and molecularity of reaction, Integrated rate equation of zero order, first order and second order reactions.

UNIT 5: **08 lecture hours**

Water Technology: Sources and impurities of water, Municipality waste water treatment, Hardness of water, Disadvantages of hard water, Techniques for water softening (Lime-Soda, Zeolite, Ion Exchange and Reverse Osmosis process), Numerical problems.

Fuels and Combustion: Definition, Classification, Characteristics of a good fuel, Calorific Values, Gross & Net calorific value, Determination of calorific value by Bomb Calorimeter, Theoretical calculation of calorific value by Dulong's method, Ranking of Coal, Analysis of coal by Proximate and Ultimate analysis method, Numerical problems.

Laboratory:

1. Determination of alkalinity in the given water sample.
2. Determination of Strength of strong acid using pH - Meter
3. Determination of Temporary and Permanent hardness in water sample using EDTA as standard solution.
4. Determination of available chlorine in bleaching powder.
5. Determination of chloride content in the given water sample by Mohr's method.
6. Determination of Iron content in the given Iron ore sample by using [K3Fe(CN)6] as an external indicator.
7. Determination of solubility of salt (NaCl) at room temperature.
8. Determine the viscosity of a given solution.
9. Element detection and Functional group identification in organic compounds.
10. Preparation of Bakelite & Urea Formaldehyde resin.
11. Verification of Beer's law.
12. Determination of surface tension of given liquid.
13. Determination of rate constant of hydrolysis of esters.
14. Determination of molecular weight of a polymer using Ostwald's viscometer
15. To determine moisture, volatile matter and ash content of a given coal sample

NOTE: Choice of any 10 experiments from the above.

Text/Reference Books:

1. Experiments in Applied Chemistry: Dr. Sunita Rattan, S.K. Kataria & Sons.
2. Laboratory Manual on Engineering Chemistry: S. K. Bhasin, Sudha Rani, Dhanpat Rai Publishing Company.
3. Advanced Inorganic Analysis: Agarwal & Keemti Lal, Pragati Prakashan.
4. Vogel's Textbook of Quantitative chemical analysis: J. Mendham et.al., Pearson Education.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS2003/ BCS2053	Object Oriented Programming	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To examine different programming structures in a platform independent language such as wrapper classes, collections, exceptions, and multithreading.
CO2: To explain the concepts of object-oriented programming like encapsulation, abstraction, inheritance and polymorphism.
CO3: Make use of GUI and database-based programming to develop Applications for real life problems.

Course Contents:

UNIT 1: **10 lecture hours**

Handling user input/output using Scanner class, Platform independence of Java (JVM), Operators (unary, arithmetic, logical, shift left, shift right, ternary, assignment) Exploring bitwise operators, compound assignment, if/else, Using switch for menu-driven applications while, For, do-while, Introduction to Abstraction and Polymorphism Objects Lifecyle: creation, dereference, garbage collection, Wrapper classes (Boolean, Integer, Double, Character), Autoboxing, unboxing, String (concoct, index of, split, length, to Lower Case, to Upper Case, replace, trim), Array declaration, instantiation, multidimensional arrays, Designing methods for modularity and reusability Static variables, Static methods, Static blocks, Constructors and destructors, Instance Initialization Blocks, Security aspects in class design Encapsulation, Inheritance, single, multilevel, Hierarchical.

UNIT 2: **11 lecture hours**

Polymorphism, Function Overloading method overriding, Concrete Class Abstraction abstract methods, non- availability of multiple inheritance, interfaces, Interfaces vs abstract class, Embedded Interface Anonymous class, Inbuilt Packages, User defined packages, Array List collection, LinkedList Collection Vector collection, Exception handling, Checked and unchecked exception, try, catch, finally, Propel, Propagate, Data Stream Handling.

UNIT 3: **11 lectures hours**

Thread and process, Parallel Computing Concurrent Programming synchronization, Swing features, JavaFX Features MySQL database, NoSQL Databases get_Connection, create_Statement, execute_Query, JEE (client-server architecture for web based applications), Microservices Architecture Running Servlet, Generic Servlet, HTTP Servlet, Servlet Config, Web Filters Servlet to handle Get and Post Methods, Startups on programming, Session Management.

UNIT 4: **10 lectures hours**

JSPs, Struts framework, Spring MVC framework Regular expressions (Lambda expressions), Collection framework Concurrency in Java, HashMap, Linked Hash Map, Tree Map, Kotlin for Android Web Sockets JPA (Java Persistence API), Microservices with Spring Boot.

Laboratory:

Students will gain hands-on experience on core JAVA. Students will be able to solve simple to medium level computation problems in Java. Emphasis will be that the student code themselves as much as they can. They learn to debug the programs resulting in error free code. Instructor will be giving assignments based on the content covered in the lecture classes in the corresponding week.

Text Books/Reference Books:

1. Schildt, Herbert. *Java: the complete reference*. 10th ed. McGraw-Hill Education Group, 2014. ISBN 978-93392120.
2. Bloch, Joshua. *Effective java (the java series)*. 1st ed. O'Reilly Media, Inc., 2017. ISBN 978-0134686097.
3. Anuradha A. Puntambekar, *ObjectOriented Programming*. 1st ed. UNICORN Publishing Group, 2020. ISBN 9789333223819.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCN2004/BCN1008/ BCN2054/BCN1058	Life Skills: Entrepreneurship, Language, Communication and Personality	L	T	P	C
Owning School/Department	FET	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Identify and correct common grammatical and writing errors for effective communication.
CO2: Apply reading and writing strategies to comprehend, summarize, and produce professional documents.
CO3: Demonstrate effective communication, leadership, and conflict management skills in practical scenarios.

Course Contents:

UNIT 1: **06 lecture hours**

Subject-verb agreement, Noun-pronoun agreement, Misplaced modifiers, Articles, Prepositions, Redundancies, Clichés

UNIT 2: **08 lecture hours**

Employing different reading skills, Comprehension passage – Understanding the author's point of View, the art of condensation- Summarization, paraphrasing, précis and abstract writing, reading short stories (Rabindranath Tagore, Munsi Premchand, Mulk Raj Anand and James Joyce), Writing business letters and reports

UNIT 3: **14 lecture hours**

Process and principles of effective business communication, Types of Communication-(Verbal Communication, Non-verbal Communication, Interpersonal Communication, Extra personal Communication, Intrapersonal Communication, Mass Communication and Media Communication etc., Barriers to communication, Remedies to overcome from the barriers of Communication

UNIT 4: **14 lecture hours**

Oral and Written Presentations: Technical Communication, Essential Elements of Effective Presentations and Speaking as a Leader, Gaining Power and Influence: Building a Strong Power Base, Motivating Others and Diagnosing Work Performance Problems, Managing Conflict: Interpersonal and Collaborative Approaches, Case Studies and Practice Sessions

Laboratory:

1. Group Discussion, Conversations and dialogue- Practical based on relevant Grammatical Patterns.
2. Practice of Communication Skills for Seminars/Conferences/Workshops with emphasis on Paralinguistic /Kinesics.
3. Presentation Skills for Technical Paper/Project Reports/ Professional Reports based on proper Stress and Intonation Mechanics

4. Public Speaking practice by conducting elocution, extempore, debate and speech competition
5. Theme Presentation/ Keynote Presentation based on correct methodologies
6. Individual Speech Delivery/Conferencing with skills to defend Interjections/Quizzes
7. Argumentative Skills/Role Play Presentation with Stress and Intonation.
8. Comprehension Skills based on Reading and Listening Practical's on a model Audio

Text Books/Reference Books:

1. Wood, F.T. *Remedial English Grammar*. Macmillan, 2007.
2. Kumar, Sanjay and Pushp Lata. *Communication Skills*. Oxford University Press, 2011.
3. Seely, John. *Oxford Guide to Effective Writing and Speaking*. Oxford University Press, 2013.
4. Sudharshana, N.P., and C. Savitha. *English for Engineers*. Cambridge University Press, 2018.
5. Joyce, James. *Dubliners (Modern Classics)*. Penguin Books, 2000.
6. Tagore, Rabindranath. *The Home-Coming*. CI Publisher, 2014.
7. Anand, Mulk Raj. *The Lost Child and Other Stories*. Orient Publishing, 2004.
8. McCarthy, Michael, and Felicity O'Dell. *English Vocabulary in Use (Intermediate)*. Cambridge University Press, 2002.
9. Quirk, Randolph. *A Comprehensive Grammar of the English Language*. Pearson Education India, 2010.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCN2005	Universal Human Values-II: Understanding Harmony And Ethical Human Conduct	L	T	P	C
Owning School/Department	FET	2	1	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Understand the complementary role of values and skills in achieving lasting happiness and prosperity, the core aspirations of all humans.
CO2: Develop a holistic perspective on life, profession, happiness, and prosperity, grounded in a correct understanding of human reality and existence, fostering universal human values and value-based living.
CO3: Recognize the implications of a holistic perspective for ethical conduct, trustful and fulfilling human behaviour, and mutually enriching interactions with nature.

Course Contents:

UNIT 1: **06 lecture hours**

Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education), Understanding Value Education Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfil the Basic Human Aspirations.

UNIT 2: **06 lecture hours**

Understanding Human being as the Co-existence of the Self and the Body, distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health.

UNIT 3: **06 lecture hours**

Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order

UNIT 4: **04 lecture hours**

Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four, Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence

UNIT 5: **06 lecture hours**

Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for, Humanistic Education, Humanistic Constitution and Universal, Human Order, Competence in Professional Ethics, Holistic Technologies, Production Systems and Management Models-Typical, Case Studies, Strategies for Transition towards Value-based Life and Profession, Human Order

Tutorial:

1. Sharing about Oneself
2. Exploring Human Consciousness
3. Exploring Natural Acceptance
4. Exploring the difference of Needs of Self and Body
5. Exploring Sources of Imagination in the Self
6. Exploring Harmony of Self with the Body
7. Exploring the Feeling of Trust
8. Exploring the Feeling of Respect
9. Exploring Systems to fulfil Human Goal
10. Exploring the Four Orders of Nature
11. Exploring Co-existence in Existence
12. Exploring Ethical Human Conduct
13. Exploring Humanistic Models in Education
14. Exploring Steps of Transition towards Universal

Text Books:

1. The Textbook - A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
2. The Teacher's Manual- Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, RR Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53.
3. Professional Ethics and Human Values, Premvir Kapoor, ISBN: 978-93-86173-652, Khanna Book Publishing Company, New Delhi, 2022.

Reference Books:

1. JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – Pandit Sunderlal

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCN2007	Hobbies, Co-Curricular and Extra-Curricular	L	T	P	C
Owning School/Department	FET	2	0	0	0
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To make the students understand the importance of sound health and fitness principles as they relate to better health.
CO2: To expose the students to a variety of physical and yogic activities aimed at stimulating them continued inquiry about Yoga, physical education, health and fitness.
CO3: To create a safe, progressive, methodical and efficient activity-based plan to enhance improvement and minimize risk of injury.
CO4: To develop among students an appreciation of physical activity as a lifetime pursuit and a means to better health.

Course Contents:

UNIT 1: **02 lecture hours**

Meaning & definition of Physical Education, Aims & Objectives of Physical Education, Changing trends in Physical Education

UNIT 2: **02 lecture hours**

Ancient & Modern Olympics (Summer & Winter), Olympic Symbols, Ideals, Objectives & Values, Awards and Honours in the field of Sports in India (Dronacharya Award, Arjuna Award, Dhayanchand Award, Rajiv Gandhi Khel Ratna Award etc.)

UNIT 3: **02 lecture hours**

Meaning & Importance of Physical Fitness & Wellness, Components of Physical fitness, Components of Health-related fitness, Components of wellness, Preventing Health Threats through Lifestyle Change, Concept of Positive Lifestyle

UNIT 4: **02 lecture hours**

Define Anatomy, Physiology & Its Importance, Effect of exercise on the functioning of Various Body Systems. (Circulatory System, Respiratory System, Neuro-Muscular System etc.)

UNIT 5: **02 lecture hours**

Meaning & Importance of Kinesiology & Biomechanics in Physical Edu. & Sports, Newton's Law of Motion & its application in sports, Friction and its effects in Sports.

UNIT 6: **02 lecture hours**

Meaning and Concept of Postures, Causes of Bad Posture, Advantages & disadvantages of weight training, Concept & advantages of Correct Posture, Common Postural Deformities – Knock Knee; Flat

Foot; Round Shoulders; Lordosis, Kyphosis, Bow Legs and Scoliosis, Corrective Measures for Postural Deformities

UNIT 7: **02 lecture hours**

Meaning & Importance of Yoga, Elements of Yoga, Introduction - Asanas, Pranayama, Meditation & Yogic Kriyas, Yoga for concentration & related Asanas (Sukhasana; Tadasana; Padmasana & Shashankasana), Relaxation Techniques for improving concentration - Yog-nidra

UNIT 8: **02 lecture hours**

Asanas as preventive measures, Hypertension: Tadasana, Vajrasana, Pavan Muktasana, Ardha Chakrasana, Bhujangasana, Sharasana, Obesity: Procedure, Benefits & contraindications for Vajrasana, Hastasana, Trikonasana, Ardh Matsyendrasana., Back Pain: Tadasana, Ardh Matsyendrasana, Vakrasana, Shalabhasana, Bhujangasana, Diabetes: Procedure, Benefits & contraindications for Bhujangasana, Paschimottasana, Pavan Muktasana, Ardh Matsyendrasana, Asthema: Procedure, Benefits & contraindications for Sukhasana, Chakrasana, Gomukhasana, Parvatasana, Bhujangasana, Paschimottasana, Matsyasana.

UNIT 9: **02 lecture hours**

Meaning of Training, warming up and limbering down, Skill, Technique & Style, Meaning and Objectives of Planning, Tournament – Knock-Out, League/Round Robin & Combination.

UNIT 10: **02 lecture hours**

Definition & Importance of Psychology in Physical Edu. & Sports, Define & Differentiate Between Growth & Development, Adolescent Problems & Their Management, Emotion: Concept, Type & Controlling of emotions, Meaning, Concept & Types of Aggressions in Sports, Psychological benefits of exercise, Anxiety & Fear and its effects on Sports Performance, Motivation, its type & techniques, Understanding Stress & Coping Strategies.

UNIT 11: **02 lecture hours**

Meaning and Concept of Doping, Prohibited Substances & Methods, Side Effects of Prohibited Substances

UNIT 12: **02 lecture hours**

First Aid – Definition, Aims & Objectives, Sports injuries: Classification, Causes & Prevention, Management of Injuries: Soft Tissue Injuries and Bone & Joint Injuries

UNIT 13: **02 lecture hours**

Athletics, Badminton, Basketball, Chess, Cricket, Kabaddi, Lawn Tennis, Swimming, Table Tennis, Volleyball, Yoga etc, History of the Game/Sport, Latest General Rules of the Game/Sport, Specifications of Play Fields and Related Sports Equipment, Important Tournaments and Venues, Sports Personalities, Proper Sports Gear and its Importance.

Text Books/References:

1. Modern Trends and Physical Education by Prof. Ajmer Singh.
2. Light On Yoga by B.K.S. Iyengar.
3. Health and Physical Education – NCERT (11th and 12th Classes)

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCN2059	Design Thinking and Innovation	L	T	P	C
Owning School/Department	Computer Science and Engineering	0	0	2	1
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Explain the concepts of design thinking.
CO2: Conceptualize and ideate solution for an existing problem using Computing resources and computing devices.
CO3: Implement the concept to create and prototype the idea into near workable solution.

Course Contents:

UNIT I: **28 lecture hours**

Students are set to embark on a group project designed to foster a holistic understanding of the design thinking approach applied in project development. Continuous assessments will gauge their performance against various project-related criteria. The project entails the creation of a poster, video, blog, report, and presentation, enabling students to explore different deliverables and associated documentation. The focus is on tackling real-world problems and actionable issues, utilizing technology and improved design for effective solutions.

Studio Work / Laboratory Experiments:

The course will be taught using a combination of the best practices of teaching-learning. Multiple environments will be used to enhance the outcomes such as seminar, self-learning, MOOCs, group discussions and ICT based tools for class participation along with the classroom sessions. The teaching pedagogy being followed includes more exposure to hands-on experiment and practical implementations done in the lab sessions. To make the students aware of the industry trends, one session of expert lecture will be organized to provide a platform to the students for understanding the relevant industry needs.

Text Books/ Reference Books:

1. E Balaguruswamy (2022), Developing Thinking Skills (The way to Success), Khanna Book Publishing Company.

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Semester-III

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS3001	Mathematics III	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	1	0	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Demonstrate knowledge of probability and the standard statistical distributions.

CO2: Demonstrate knowledge of fixed-sample and large-sample statistical properties of point and interval estimators.

CO3: Demonstrate knowledge of the properties of parametric, semi-parametric and nonparametric testing procedures.

Course Contents:

UNIT 1: **08 lecture hours**

Data and Classification: Data type, Classification and summarization of data, Diagrams and Graphs, Measures of central tendency, Measures of dispersion, Moments, Skewness, kurtosis.

UNIT 2: **08 lecture hours**

Probability and Distributions: Introduction to probability, Laws of probability, Bayes' theorem, Expectation and Random variable, Binomial distribution, Poison distribution, Normal distribution.

UNIT 3: **10 lecture hours**

Correlation, Regression and Tests: Correlation, Pearson and Mathew correlation, Coefficient, Co-efficient of correlation, Rank Correlation, Lines of regression, Linear and Nonlinear regression, Multiple regression, Non-Parametric tests, Sign test, Mann-Whitene Wilcoxon test.

UNIT 4: **08 lecture hours**

Tests of Hypothesis and ANOVA: Hypothesis tests, Student's t-test, Chi squire test, F-test and ANOVA, One way and two-way analysis of variants.

UNIT 5: **08 lecture hours**

Design and Quality Control: Principles of experimental design and analysis, Completely randomized design, Randomized block design, Latin square design, Statistical quality control, Types of quality control, Control chart for variables, Control chart for attributes.

Text Books:

1. S. P. Gupta, Statistical Methods; Sultan Chand & Sons Publishers.
2. Georgr W. and William G., Statistical Methods; IBH Publication.
3. Ipsen J et al; Introduction to Biostatistics, Harper & Row Publication.
4. B. S. Grewal, Higher Engineering Mathematics, Khanna Publisher, 2005.

Reference Books:

1. N. T. J. Baily; Statistical methods in Biology; English University Press.
2. R. Rangaswami; A Text book of Agricultural statistics; New Age Int.Publication.
3. P. S. S. Sundar Rao; An Introduction to Biostatics; Prentice Hall.
4. Zar J; Biostatistics; Prentice Hall, Londan.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS3002/ BCS3052	Operating Systems	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To explain the structure and the services provided by the Operating System.
CO2: To define, restate, discuss, and explain the policies for scheduling, deadlocks, memory management, synchronization, system calls, and file systems.
CO3: To examine distributed Operating System, cloud computing, and Virtualization.

Course Contents:

Course Contents:

UNIT I: **09 lecture hours**

Operating system: Organization, abstraction provided by OS, features and roles, OS evolution, Operating system architecture, OS examples; Process management: Process control block, system calls and interrupts, context switching, schedular and dispatcher, process states and life cycle, multithreading, kernel vs. user level threads, process vs. thread; CPU scheduling algorithms: FCFS, SJF, STRF, priority, round robin, multilevel queue and feedback scheduling, highest response ration next, lottery scheduling.

UNIT II: **09 lecture hours**

Inter process communication, shared memory method, message passing method and its types; Process synchronization, critical section problem (CSP), synchronization constructs, hardware solutions to CSP- Lock variables, software solutions to CSP-Peterson solutions, strict alteration; Classical synchronization problem: Producer consumer problem, dining philosopher problem, reader writer problem, monitor; Deadlock, necessary condition for deadlock, deadlock handling mechanism: prevention, avoidance, detection; resource allocation graph, deadlock recovery.

UNIT III: **12 lecture hours**

Memory management, techniques, Contiguous: Fixed and variable length partitioning, Non-contiguous: Paging, translation lookaside buffer (TLB), multilevel paging, segmentation, segmented paging; Virtual memory, dynamic loading, demand paging, page fault, thrashing, Page replacement algorithms: First in First Out (FIFO), Least Recently Used (LRU), Optimal Page Replacement; File organization, access mechanism, file allocation methods - Contiguous allocation, linked allocation, indexed allocation, Indexing techniques: Single indirect block, double indirect blocks; Storage management, storage devices – HDD, SSD; disk architecture, disk performance metrics; Disk scheduling algorithms: FCFS, SSTF, SCAN, C-SCAN, LOOK, C-Look, NOOP and deadline schedular.

UNIT IV: **12 lecture hours**

Distributed systems, network vs. distributed OS, robustness analysis, design issues; Remote procedure call (RPC), structure, parameter passing, handling partial failures, SunRPC and XDR; Distributed file systems, Servers: stateless and stateful, REST; Distributed shared memory, architecture, design principles, consistency model; Security systems calls, authentication & authorization, reliability, availability & privacy, common attacks, crypto systems, Kerberos, access control lists; OS design: MAC, and iOS; Virtualization: Types, models; Cloud computing, architecture, service and deployment models, cloud challenges.

Laboratory:
Students will gain practical experience with the implementation and use of operating system functions such as process management, inter-process communication, process synchronization, memory management and file systems etc. Moreover, students will have exposure to the tools for measuring and monitoring of operating systems related parameters and services.

Text Books:

1. *Andrew S. Tanenbaum and Herbert Bos "Modern Operating Systems", 5th Edition 2023.*
2. *Behrouz A. Forouzan, "Data Communications and Networking", Edition 6th ,2022, McGraw-Hill Education.*
3. *Silberschatz, Abraham, Peter B. Galvin, and Greg Gagne. Operating System Concepts. 10th ed. John Wiley & Sons, 2018. ISBN 978-1-119-32091-3.*
4. *Stallings, William. Operating systems: internals and design principles. 9th ed. Prentice Hall Press, 2021. ISBN 978-0134670959.*

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS3003/ BCS3053	Information Management System	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Articulate the competent understanding of database systems design and ER Modelling.
CO2: Build database systems and understand new developments and trends in databases.
CO3: Construct databases and make use of efficient SQL queries to retrieve and manipulate data as required.

Course Contents:

UNIT 1: **06 lecture hours**

Databases and DBMS - Traditional and Modern, Data Models: Relational, NoSQL - Key-Value, Document, Column-Family, Graph, Hierarchical and Network Models - Historical Context and Limitations, Database System Architecture - Centralized and Distributed, Cloud Databases

UNIT 2: **08 lecture hours**

ER Model: Entities, Attributes, Relationships, Enhanced ER Model, Mapping ER to Relational Model, Relational Model Concepts, Constraints, and Keys, SQL: DDL, DML, DCL, Advanced SQL: Joins, Views and Triggers, Indexing

UNIT 3: **06 lecture hours**

Database Anomalies and Renormalization, Functional Dependencies and Decomposition, Normal Forms - 1NF, 2NF, 3NF, BCNF, Database Design Process

UNIT 4: **06 lecture hours**

ACID Properties and Serializability, Concurrency Control Mechanisms: Locks, Timestamp Ordering, Recovery Mechanisms: Log-Based Recovery, Checkpointing

UNIT 5: **08 lecture hours**

Semi-Structured Data: JSON, Distributed Databases and Replication, NoSQL Data Models and Systems: Document Databases – MongoDB, NoSQL Data Models and Systems: Key-Value Stores – Redis, Cloud Database Services - AWS, Azure, GCP, MapReduce, Modern Distributed Processing

UNIT 6: **08 lecture hours**

Data Warehousing and OLAP Concepts, Data Analytics Integration with Databases, Graph Databases and Applications -Neo4j, Database Security: Common Threats and Vulnerabilities, Database Security: Authentication, Authorization, and Access Control, Encryption and Auditing, Trends - AI/ML, Data Lakehouse and Comparison of Commercial and Open-Source DB

Laboratory:

1. Database Concepts and Environment Setup -RDBMS and NoSQL
2. ER Modeling and Relational Schema Design
3. SQL Queries -DDL, DML, DCL

4. SQL Queries -Joins, Subqueries
5. Database Normalization
6. Database Design Case Study Implementation
7. Implementing Transaction Management in SQL
8. MongoDB: Installation and CRUD Operations
9. Redis: Operations
10. Exploring Cloud Database Services -e.g., AWS RDS Free Tier
11. Neo4j: Graph Database Creation and Querying
12. Database Security Lab: SQL Injection Prevention or User Management

Text Book:

1. Raghurama Krishnan, Johannes Gehrke, "Database Management Systems", TATA McGraw-Hill 3rd Edition, 2022.
2. Silberschatz, Abraham, Henry F. Korth, and Shashank Sudarshan. Database system concepts. 7th ed. McGraw-Hill, 2011. ISBN 9780078022159.
3. Ramez Elmasri and Sham Navathe, Fundamentals of Database Systems. 1 ed. Pearson/Addison Wesley, 2016. ISBN 9780133970779.

Reference Books:

1. Negi, Mukesh. *Fundamental of Database Management System: Learn essential concepts of database systems*. 1st ed. BPB Publications, 2019. ISBN 9789388176626.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS3006/ BCS3056	UI/UX Design	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To explain UI design with components and user experience designing.
CO2: To implement UI/UX components and libraries.
CO3: Develop interactive prototypes and design solutions that align with accessibility standards and enhance user experience.

Course Contents:

UNIT 1: **11 lecture hours**

Historical evolution GUI, Interactive system design: Concept of usability, HCI and software engineering, GUI design and aesthetics, Prototyping techniques, Heuristic Evaluation, Experimental Design, Importance and benefits of good design, Screen design. Scenarios, Design Process. Characteristics of user interface, Web user – Interface popularity, Psychology and Human factors, Conceptual Models, Mistakes and Error, Cognitive models, Socio-Organizational and stakeholder requirements, Social Computing, Experiments designing concepts and methods, Communication and collaboration models, Mobile Ecosystem: Platforms.

UNIT 2: **10 lecture hours**

Application frameworks, Widgets, Applications, Mobile Design: Elements, Tools, Mobile design case studies, Human interaction with computers, design rules, Universal Design Models and Theories, Interface implementation & evaluation, Communication and collaboration models, Power of the Crowd, crowdsourcing, Internet of things in HCI, Experimental Design. Experiments designing concepts, exploring design for HCI, GOMS for HCI, Identify Color Guidelines, Stages of action in interaction, Menu types and design, Construction of Prototype, Design Principles for HCI.

UNIT 3: **7 lecture hours**

HCI for navigation design, Forms and behavior, Design and data for HCI, One factor test with human subjects, Ubiquitous computing with design analysis, Interface implementation, A/B testing, T-tests, Data assumptions and distributions, Interpretation of non-numeric response, Generalized linear models Case studies.

Laboratory:

Students will learn to understand the trouble of interacting with machines and design a system based on user-centered approach.

Text Books:

1. *Bhattacharya, Samit. Human-Computer Interaction: User-Centric Computing for Design. McGraw-Hill Education, 2019. ISBN 9789353168056.*

2. *Thakur, Nirmalya, and B. D. Parameshachari, eds. Human-Computer Interaction and Beyond: Advances Towards Smart and Interconnected Environments (Part II). Bentham Science Publishers, 2022. ISBN 9789814998826.*

Reference Books:

1. Preece, Jenny, Yvonne Rogers, Helen Sharp, David Benyon, Simon Holland, and Tom Carey. *Human-1. computer interaction.* Addison-Wesley Longman Ltd., 1994.ISBN 9781119547358

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS3004/ BCS3054	Data Structures and Algorithms	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To explain basic data structures for storage and retrieval of ordered or unordered data. Data structures include arrays, linked lists, binary, trees, heaps, and hash tables.
CO2: To implement algorithms for the creation, insertion, deletion, searching, and sorting of each data structure.
CO3: To examine and compare algorithms for efficiency using Big-O notation.

Course Contents:

UNIT 1: **14 lecture hours**

Asymptotic notation, Recursion, Masters theorem, Array storage, Memory allocation in 2D array, Static vs dynamic memory allocation, Binary search, Array search, traverse, insertion, and deletions, Linked list, Linked list modifications (circular, doubly), Traverse, insertion, and deletions in linked list.

UNIT 2: **12 lecture hours**

Stack representation, Application of stacks, Traverse, insertion, deletions in stack, Queue representation, Application of queue, Modifications in queue (circular, priority), Traverse, insertion, deletions in queue, Tree representation, Binary tree, Heap representation, Extract min, search, insertion operations in heap.

UNIT 3: **16 lecture hours**

Graph representation, BFS, DFS algorithms, Divide and conquer algorithm, Sorting techniques, Greedy algorithm, Coin exchange problem, Frog jump problem (proof of correctness), Dynamic algorithm, MCM, 0-1 and fractional knapsack.

Text Books:

1. *Karumanchi, Narasimha. Data Structures and Algorithmic Thinking with Python. 1st ed. CareerMonk Publications, 2016.*
2. *Cormen, Thomas H., Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. Introduction to algorithms. 4th ed. MIT press, 2022.*

Reference Books:

1. Dedov, Florian. *A Complex Subject Simply Explained (Runtime Complexity, Big O Notation, Programming).* 1st ed. Amazon Digital Services LLC - KDP Print US, 2020.
2. Wengrow, Jay. *A Common-Sense Guide to Data Structures and Algorithms* 2nd ed. O'Reilly, 2020.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS3005/ BCS3055	AI and Machine Learning	L	T	P	C
Owning School/Department	Computer Science and Engineering	2	0	2	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1 : Articulate various supervised and unsupervised machine learning approaches.
CO2 : Build and evaluate models generated from data.
CO3 : Implement systems to solve real life problem using AI and Machine Learning approaches.

Course Contents:

UNIT I: **06 lecture hours**

Designing a learning system, Types of machine learning: Problem based learning, Supervised learning, Unsupervised learning, Reinforcement learning, Linear Regression: Weights and Features, Applications, Cost Functions, Finding best fit line, Gradient Descent Algorithm: Learning Algorithm, First order derivatives, Linear regression using gradient descent, Learning rate, Logistic Regression, Sigmoid Function, Cost Function for Logistic Regression, Multi-class classification, Probability Distribution, SoftMax Function, Polynomial Regression, Performance Metrics: Classification (Confusion Matrix, Accuracy, Precision, Recall, F1-score, ROC-AUC), Regression (MSE, MAE, RMSE, R2 Score).

UNIT II: **06 lecture hours**

Decision Tree, Selecting Best Splitting Attribute, CART (Gini Index). ID3 (Entropy, Information Gain), Hyperparameters in Decision tree, Issues in Decision tree learning. Overfitting and Underfitting, Bias and Variance, Cross Validation. Ensemble Learning (Concord's Theorem), Bagging, Bootstrap and Aggregation, Random Forest. Boosting, AdaBoost, Gradient Boost. Feature Engineering, Feature Selection, Feature Extraction.

UNIT III: **06 lecture hours**

Artificial Neural Network, Neural network representation, Perceptron model, Stepwise v/s Sigmoid function, Multilayer perceptron model, Matrix Calculus (Jacobian, Hessian Matrix), Computation Graph, Backpropagation Algorithm, Activation Functions, Stochastic Gradient Descent, Batch Gradient Descent, Mini-Batch Gradient Descent, Vanishing and Exploding Gradients, Overfitting Problem, Regularization (Ridge, Lasso, Elastic), Dropout and Early Stopping, Bayesian Learning: Bayes theorem and concept learning, Naïve Bayes classifier, Gibbs Algorithm, Bayesian belief networks, The EM algorithm, Support Vector Machines, Hyperplane, Support Vectors, Kernels, Non-Parametric Regression, Locally weighted regression, K-nearest neighbour.

UNIT IV: **05 lecture hours**

Unsupervised learning (clustering, Association rule learning, Dimensionality reduction), Common distance Measures, k-means clustering, Elbow method, Hierarchical Clustering – agglomerative and

divisive, Dendogram, Similarity measures for hierarchical clustering, DBSCAN, Cluster Quality (R index, Silhouette Coefficient), Dimensionality Reduction, Principal Component Analysis, Singular Vector Decomposition, T-distributed Stochastic Neighbour Embedding.

UNIT V: **05 lecture hours**

Population Based Algorithms: Genetic Algorithm, Fitness Function, Selection, Crossover, Mutation, Swarm Optimization, Particle Swarm Optimization, Ant-Colony Optimization, Reinforcement Learning, Actors, State, Reward Policy, Actions, Computer Vision, Convolutional Neural Networks, Deep Learning for Sequential Data, Recurrent Neural Network, LSTM, GRU, Natural Language Processing, Word Embeddings, Transformers (BERT and GPT), Building and Deploying ML models (MLFlow), MLOps, Need of MLOps, ML Production Infrastructure.

Laboratory:

It is concerned with the design, analysis, implementation, and applications of programs that learn from experience. Learning algorithms can also be used to model aspects of human and animal learning.

Text Books :

1. Mitchell, Tom M. *Machine Learning*. 1st ed. McGraw Hill, 2017. ISBN 978-1259096952.
2. Alpaydin, Ethem. *Introduction to machine learning*. 4th ed. Phi, 2020. ISBN 978-8120350786.

Reference Books :

1. Campesato, Oswald. *Artificial intelligence, machine learning, and deep learning*. 1st ed. Mercury Learning and Information, 2020. ISBN 9781683924665.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Semester-IV

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS4001/ BCS4051	Computer Networks	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Examine the functionality of the different layers within network architecture.
CO2: Illustrate TCP/IP model suite protocols.
CO3: Design the networks for organization and select the appropriate networking architecture and technologies, subnetting and routing mechanism.

Course Contents:

UNIT 1: **09 lecture hours**

Why Computer Networks: Applications of Networks, Transmission Media, Connecting Devices, Local Area Networks: LAN topologies: Bus topology, Ring topology, Star topologies, Mesh topology, Hybrid topology, OSI reference model, TCP/IP Protocol suite, Physical Layer: Services, Line coding scheme, Modulation, Multiplexing, Switching methods, Ethernet, Bluetooth, Wi-Fi, Wi-Fi Direct, WPA/WPA2/WPA3, Data Link layer: Services, Framing, Switches.

UNIT 2: **08 lecture hours**

Reliable Data Delivery: Error detection, Error Correction, Flow control: Stop and wait, Go Back-N, Flow control: S-R Protocol, Error control (Retransmission techniques, timers), Medium Access sublayer - Channel Allocations, LAN protocols /ALOHA protocols, CSMA, CSMA/CD, Network Layer Protocols: Services (IP, ICMP), IP addressing, sub netting, Super netting (CIDR), IPV4, IPV6.

UNIT 3: **09 lectures hours**

Routing and Forwarding, Static and dynamic routing, Unicast and Multicast Routing, Distance-Vector Routing, Link-State Routing, Shortest path computation-Dijkstra's algorithm, Address mapping-ARP, RARP, BOOTP, DHCP, Transport Layer: Services, UDP and TCP segment formats, connection establishment and termination, Expert Lecture from Industry, Congestion control, Congestion control: Open Loop and closed loop, Quality of service, Flow characteristics, Techniques to improve QoS.

UNIT 4: **07 lectures hours**

Session Layer: Services, Protocols, Presentation layer: Services, Protocols, Application layer: Services, DNS, SIP, RTP, Telnet/SSH, HTTP, HTTPS, Remote login, Electronic mail, SMTP, FTP Commands and Replies, WWW, SNMP, Addressing Schemes, Uniform Resource Identifiers.

UNIT 5: **09 lectures hours**

Principles of Cryptography, Symmetric key, Public key, Authentication protocols, Digital signatures, Firewalls, Security in different layers: Secure E-mail SSL, IP security, Advanced Topics in CN: Dark Net, CASS: Content-Aware Search System, Service-centric networking, Software-defined networking, Cloud Systems: Services, Data centre, 4G and 5G Networks, Body area sensor Networks, Satellite networks, SWARM networks.

Laboratory:

Study of different types of networks cables and practically implement the cross-wired cable and straight through cable using clamping tool. Configure a network topology, connect different networks, static routing and dynamic routing, virtual LAN, RIP and OSPF using packet tracer. Also, Wireshark will be used for network troubleshooting, analysis, software, and communications protocol development.

Text Books:

1. *Forouzan, Behrouz A. Data communications and networking. 5th ed. McGraw Hill, 2021. ISBN 1260597822.*
2. *Wetherall, David J., and Andrew S. Tanenbaum. Computer networks. 6th ed. Pearson Education, 2021. ISBN 9780137523214.*

Reference Books:

1. Kurose, James F. *Computer networking: A top-down approach featuring the internet.* 6th ed. Pearson Education India, 2017. ISBN 9781485832535.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS4002	Discrete Mathematics	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	1	0	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1 : To explain logical notation to illustrate sets, relations, functions, and integers.
CO2 : To examine induction hypotheses and prove elementary properties of modular arithmetic.
CO3 : Experiment and solve critical examples of algebraic structures and graph theory.

Course Contents:

UNIT 1: **08 lecture hours**

Mathematical Logic - Propositions, Predicates, and Logical Connectives, Tautologies and Logical Equivalence using Truth Tables, Rules of Inference - Modus Ponens, Modus Tollens, Hypothetical Syllogism, Proof Techniques - Direct Proofs with Examples, Proof by Contradiction and Counter Examples, Mathematical Induction - Principle and Applications

UNIT 2: **08 lecture hours**

Defining Sets and Notation - Sets, Subsets, and Venn Diagrams, Set Types and Operations - Union, Intersection, Complement, Difference, Set Operations - Cartesian Products and Power Sets, More on Sets - Cardinality and Countability, Relations - Ordered Pairs and Types of Relations - Reflexive, Symmetric, Transitive, Types of Relations - Equivalence Relations and Residue Classes, Functions and Properties - One-To-One, Onto, and Bijective Functions

UNIT 3: **10 lecture hours**

Fundamental Principles of Counting - Addition and Multiplication Rules with Examples, Counting Problems - Permutations and Examples, Combinations and Examples, Binomial Coefficients - Properties and Binomial Theorem, Inclusion-Exclusion Principle - Applications in Counting Problems, Pigeonhole Principle - Concept and Applications, Generating Functions - Introduction and Applications to Counting, Linear Homogeneous Recurrence Relations with Constant Coefficients

UNIT 4: **08 lecture hours**

Greatest Common Divisors - GCD - Euclidean Algorithm, Prime Numbers - Fundamental Theorem of Arithmetic and Infinity of Primes, Congruences and Modular Arithmetic - Modular Operations and Properties, Modular Division - Inverses and Solving Modular Equations, Applications of Number Theory – Cryptography

UNIT 5: **08 lecture hours**

Graph - Directed, Undirected, Multi, Representation - Adjacency Matrix, Adjacency List, Graph Terminology and Special Types of Graphs - Complete, Bipartite, Cycle, Star, Graph Isomorphism, Connectivity in Graphs - Paths, Circuits, Connected Components, Eulerian Paths and Circuits - Existence and Algorithms, Hamiltonian Paths and Circuits, Graph Coloring - Vertex Coloring, Chromatic Number, Bipartite Graphs - Properties and Characterization, Planar Graphs - Euler's Formula and Non-Planar Graphs, Trees - Definitions, Properties, and Examples

Text Books:

1. *Reinhard Diestel. Springer Berlin, "Graph Theory". Heidelberg Sixth Edition, 2025.*
2. *Kenneth Rosen, Mcgraw - Hill, "Discrete Mathematics and Its Applications", 8th Edition, 2021.*

3. Bisht, Raj Kishor, and H. S. Dhami. *Discrete mathmatics.* 1st ed. Oxford University Press. 2015. ISBN 97- 80199452798.

Reference Books :

1. Fortney, Jon Pierre. *Discrete Mathematics for Computer Science: An Example-based Introduction.* 1st ed. CRC Press, 2020. ISBN 978-1000296806.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS4006/ BCS4056	Full Stack and Web Development	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To understand the Client-Server architecture and the basics of client-side programming languages and frameworks.
CO2: To examine of client-side languages: HTML, CSS, and JavaScript.
CO3: To implement client-side application development.

Course Contents

UNIT 1: **18 lecture hours**

Why Full Stack Development? Web development vs Full Stack Development , Client-Server architecture , Rules of three-tier architecture, MEAN, MERN, Rails, Django Stack and LAMP, MEAN vs MERN stack, Front End Frameworks and Libraries, Web, Web Browser, Web Server, Anatomy of a Website, Developer tools, inspector, Wireframing , Web hosting steps, HTML, HTML Document Object Model, W3C standards for HTML, HTML Validation, Structural markup , Semantic markup, HTML Lists, Links , Absolute versus relative path names , URL: Anatomy, Types, HTML Formatting , HTML Tables, Meta tags, Structural tags, Character entities,escape codes, Image maps, Font awesome Icons , Forms Input Types.

UNIT 2: **10 lecture hours**

Why CSS? W3C CSS Validator, Syntax, Types, CSS Selectors, Cascading, Inheritance, Specificity, UNITs of Measure, Width and Height of element, Box Model Layout, Border Box Versus Content Box, Responsive website Design Bootstrap Grid System, CSS pre-processor:Less, Sass and features.

UNIT 3: **14 lecture hours**

JavaScript, JavaScript Events, JavaScript APIs, Expert Lecture from Industry, Ajax Web App Flow, Ajax Process Refreshing ES6 Specifications and Features ECMA Script, ES6 let and const, The arrow functions, ES6 Classes Inheritance, Spread Operator, Iterators and Generators, React, React in HTML, React in CSS, Built in libraries Leveraging Virtual DOM, Setting up React, Configure git/client, Creating Repositories, push local repositories to GitHub, Git Branching and Merging , Web Publishing ethics, Hosting a website.

Laboratory:

In studio work, developers develop both the front-end and the server-side of the application, deploy, debug and maintain their databases and servers. Being a Full Stack Web Developer, you will be at an edge as you make better technical decisions and see the big picture.

Text Books:

1. Flanagan, D., *JavaScript: The Definitive Guide* (7th ed.), Shroffand O'Reilly Media, 2020. ISBN 978935213996.

2. Robbins, J., *Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics* (5th ed.), O'Reilly Media, 2020. ISBN 978-1491960158.

Reference Books:

1. Meloni, J.C. and Kyrnin J, *HTML,CSS, and JavaScript All in One, SamsTeach Yourself* (5th ed.), Pearson, 2018. ISBN 9789389552416.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS4003/ BCS4052	Software Engineering and System Design	L	T	P	C
Owning School/Department	Computer Science and Engineering	2	0	2	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate understanding of Software Engineering as an iterative and systematic process.
CO2: To examine the software development process to complement the technical understanding ofsoftware products.
CO3: To implement development life cycle through the IDE, UML, and Git.

Course Contents

UNIT 1: **08 lecture hours**

Introduction: Course Overview, SE vs SD Definitions, Software Crisis, SDLC Overview, Professional Ethics and Responsibility, Process Models: Waterfall, Iterative, Prototyping, Spiral, RAD Models, Agile Principles and Values; Scrum: Roles, Artifacts - Product Backlog, Sprint Backlog, Increment, Scrum Events - Sprint Planning, Daily Scrum, Sprint Review, Sprint Retrospective; XP, Requirements Engineering I: Types - Functional/Non-Functional, Elicitation Techniques, Analysis Basics, Use Cases, Specification - SRS Structure - IEEE 830, Validation, Version Control with Git: Repo, Commit, Branch, Merge, Centralized vs Distributed, Git Workflows: Feature Branching, Pull Requests, Collaboration Strategies

UNIT 2: **06 lecture hours**

Design Principles: Abstraction, Decomposition, Modularity, Cohesion, Coupling, Information Hiding, Architectural Styles: Layered, Client-Server, MVC, Microservices vs Monolith, Object-Oriented Design Review - UML: Class, Sequence Diagrams; SOLID Principles, Design Patterns: Creational - Singleton, Factory Method, Structural - Adapter, Behavioural - Observer, Strategy, Command, Secure Coding Principles and Common Vulnerabilities Overview - OWASP Top 10 Awareness

UNIT 3: **06 lecture hours**

Testing: Levels - Unit, Integration, System, Acceptance, V&V Model, Testing Techniques: Black-box - Equivalence Partitioning, Boundary Value Analysis, White-box - Statement/Branch Coverage, Unit Testing Frameworks - JUnit/pytest Concepts; Test-Driven Development - TDD Introduction, CI/CD Introduction: Concepts, Pipeline Stages - Build, Test, Deploy, Tool Awareness - Jenkins, GitHub Actions, Software Maintenance: Types, Reverse Engineering, Re-engineering, Refactoring Concepts

UNIT 4: **08 lecture hours**

Need for Scale: Defining Scalability, Availability, Latency, Throughput; Vertical vs Horizontal Scaling, Core Components I: Load Balancers - Purpose, Algorithms, CDNs, DNS role in distributed systems, Core Components II: Caching - Motivation, Layers, Eviction Policies, Redis/Memcached overview, Proxies, Data Storage at Scale: SQL vs NoSQL trade-offs, CAP Theorem Introduction, Sharding/Replication Concepts, Asynchronous Communication and Case Study: Message Queues - Purpose, Microservices Overview Recap, Simple SD Example Walkthrough

Laboratory:

1. Requirements and User Stories
2. UML Modeling
3. Git Basics and Individual Workflow
4. Git Collaboration: Branching and Merging
5. Agile/Scrum Simulation
6. Implementing Design Patterns I -Creational
7. Implementing Design Patterns II -Behavioral
8. UNIT Testing with JUNIT/pytest
9. CI/CD Pipeline
10. API Interaction
11. System Design Diagramming
12. Exploring Scalability Components -Conceptual

Text Books:

1. *Peter Spath, "Mobile App Development with Android and Kotlin", 2023.*
2. *Christian Keur and Aaron Hillegass, "iOS Programming The Big Nerd Ranch Guide", 2024.*
3. Pressman, Roger S. *Software engineering: a practitioner's approach.* 8th ed. McGraw Hill International, 2019. ISBN 978-1259253157.
4. Sommerville, Ian. *Software Engineering,* 10th ed. Pearson Education India, 2017. ISBN 978-9332582699.

Reference Books :

1. Summers, Boyd. *Effective Methods for Software Engineering.* 1 ed. CRC Press, 2020. ISBN 9781000052710.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS4004/ BCS4053	Cloud Infrastructure and Services	L	T	P	C
Owning School/Department	Computer Science and Engineering	2	0	4	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate cloud computing principles and their business need.
CO2: To identify the design principles of virtualization techniques in cloud resource management.
CO3: To design and development of cloud architectural solution with its detailed monitoring.

Course Contents:

UNIT 1: **08 lecture hours**

Cloud Computing, Adoption of cloud-based IT resources, Service Models: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS), Deployment models: Public Cloud, Private Cloud, Hybrid Cloud, CommUNITy Cloud, Cloud Computing Characteristics, Challenges of cloud computing, Virtualization concept, Types of virtualizations, Demo of virtualization, Virtualization Merits, Role of virtualization in cloud computing, Virtualization Demerits, VM Placement, VM Migration, VM Migration Demo, VM clustering, Design Issues in VM Clustering, Need of Dockers and Containers, Docker Eco-System, Hypervisor vs Docker.

UNIT 2: **08 lecture hours**

Microservices, Service-Oriented Architecture, REST API, IP Addressing, Subnetting, Super netting, Designing of Virtual Private Cloud, Demo of VPC, VPC Peering, VPC Case Study, Cloud Storage, Serverless Computing, Cloud API Gateway, Cloud Databases, Resource Provisioning, Time shared and space shared, Efficient VM Consolidation on cloud server, Task/DAG Scheduling Algorithms, Min-Min, Max-Min, MET, B-level Demo, T-level Demo, Task-VM Mapping, Auto Scaling, Load Balancing.

UNIT 3: **06 lecture hours**

Case Study: Cloud Market analysis, Security and Compliances, Shared security model in IAAS/PAAS/SAAS, Shared technology issues, Data loss or leakage, Account or service hijacking, Implementation of cloud security, Security Groups, Network Access Control Lists, Cloud databases, Parallel Query Execution with NoSQL Database, Big Data, Handling Big Data on Cloud Platform, Map- Reduce framework for large clusters using Hadoop, Design of data applications based on Map Reduce in Apache Hadoop.

UNIT 4: **06 lecture hours**

Comparative study/analysis of public clouds, Edge Computing, Fog Computing, Data Offloading, Cloud-Based DevOps Tools, Task Partitioning, Data Partitioning, Data Synchronization, Distributed File System, Data center, Ongoing Research Topics.

Laboratory:

Practical experience on global cloud infrastructure by performing experiments on Amazon Web Services (AWS), Google Cloud Platform (GCP) and Microsoft Azure platform. The essential services and their hands-on is compulsory on Core IaaS, PaaS and SaaS.

Text Books :

1. *Wang L., Rajiv Ranjan, Jinjun Chen and Boualem Benatallah, Cloud Computing (1st ed.), CRC Press, 2017. ISBN 978-1351833097.*
2. *Hurwitz J. S. and Daniel Kirsch, Cloud Computing For Dummies (2nd ed.), Hoboken: John Wiley & Sons, 2020. ISBN 978-1119546658.*

Reference Books :

1. Sharma Prerna, Moolchan Sharma and Mohamed Elhoseny, *Applications of Cloud Computing* (1st ed.), CRC Press, 2020. ISBN 9780367904128.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS4005/ BCS4054	Computer Organization and Architecture	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Understand the structure and function of computer hardware and instruction set architecture.
CO2: Examine various design alternative of computer architecture based on CPU performance, memory, I/O.
CO3: Understand instruction sets and implement with assembly program and design application specific processor using HDL.

Course Contents:

UNIT 1: **08 lecture hours**

Computer Systems and Functional UNITs, Data Representation -Integer and Floating Point, Instruction Formats, Addressing Modes, Computer Organization - CPU, Memory, I/O Components, Interconnection Structures - Buses and Hierarchies, Performance Metrics - Execution Time and Throughput, Performance Metrics - Speedup, Efficiency, and Amdahl's Law

UNIT 2: **12 lecture hours**

CPU Structure and Function - Register Organization, Instruction Cycle - Fetch, Decode, Execute Stages, Data Path Design - Single-Cycle Implementation, Multi-Cycle Implementation, Control UNIT Design - Hardwired Control, Microprogrammed Control, Pipelining - Concepts and Performance, Data Hazards and Handling Techniques, Control Hazards and Branch Prediction, Instruction-Level Parallelism - Superscalar and Out-of-Order Execution

UNIT 3: **12 lecture hours**

Memory Hierarchy - Principles and Organization, Cache Memory - Organization and Mapping Techniques, Cache Memory - Replacement Policies, Cache Memory - Performance Analysis, Virtual Memory - Concepts and Motivation, Virtual Memory - Address Translation and Page Tables, Virtual Memory - Paging and Segmentation, Translation Lookaside Buffer -TLB, Main Memory - DRAM Organization and Memory Controllers

UNIT 4: **10 lecture hours**

I/O Systems - Buses and Interface Circuits, I/O Data Transfer Techniques - Programmed I/O and Interrupts, DMA and I/O Processors, Multiprocessors and Parallel Architectures, RISC-V Architecture - Key Features and Instruction Formats, RISC vs. CISC Architecture Paradigms, RISC-V and Modern RISC Implementations, ARM Processor Architecture and Applications

Laboratory:

1. Verilog simulation environment and data path components
2. Design and simulation of a data path for a subset of instructions in Verilog
3. Implementation of a single-cycle processor in Verilog based on instruction set
4. Simulation of pipeline behavior and analysis of pipeline hazards using Verilog
5. RISC-V assembly language programming using a simulator
6. RISC-V Assembly Language - Function Calls and Procedures

7. Implementation and simulation of a cache memory model in Verilog or simulator
8. Exploring different cache mapping techniques through simulation
9. Simulation of virtual memory address translation
10. RISC-V Processor Core Design in Verilog
11. RISC-V Processor Core Implementation in Verilog
12. RISC-V Processor Core Simulation and Testing

Text Book:

1. *William Stallings, "Computer Organization and Architecture", 11th edition., Pearson, 2022.*
2. Hennessy, John L., and David A. Patterson. *Computer architecture: a quantitative approach*. 5th ed. Morgan Kaufmann, 2012. ISBN 978-9381269220.

Reference Books :

1. Stallings, William. *Computer organization and architecture: designing for performance*. 10th ed. Pearson Education India, 2016. ISBN 978- 0132936330.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCN4007	Environmental Sciences	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	0
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Demonstrate analytical thinking skills concerning environmental topics.
CO2: Demonstrate an ability to combine the many disciplines and fields that intersect with environmental concerns.
CO3: Illustrate an integrative approach to environmental issues with a focus on sustainability.

Course Contents:

UNIT 1: **06 lecture hours**

Environmental Sustainability, Ecosystems, and Climate Change: Overview of Environmental Sustainability, Sustainability and Population Growth, Exploration of Growth Curves, Way forward – Ecosystems and climate change introduction – Ecosystem dynamics –Tragedy of commons - Tragedy of commons solutions – Ecosystems and extinctions – Weather vs. Climate – Climate changes in the past – Climate change in the present – Climate processes.

UNIT 2: **05 lecture hours**

Biodiversity and its conservation: Biodiversity – Value of biodiversity – Threats to biodiversity - Conservation of biodiversity – Case studies.

UNIT 3: **08 lectures hours**

Natural resources: Natural Resources and Their Challenges, Renewable and Non-renewable Energy Sources, Water's Role in Agriculture, Agriculture's Connection to Food Production, Addressing Issues and Solutions in Agriculture and Food Production.

UNIT 4: **08 lectures hours**

Environmental pollution: Causes, effects and control measures of various types of pollutions - Air pollution - Water pollution - Wastewater treatment - Soil pollution - Noise pollution - Thermal pollution - - Solid waste management - E-waste - Case studies on pollution.

UNIT 5: **07 lectures hours**

Ethical Perspectives on the Environment, Global Environmental Policies, Environmental Legislation in India, Environmental Impact Assessment, Challenges Encountered in Enforcing Environmental Laws.

UNIT 6: **08 lectures hours**

Life cycle analysis and sustainability thinking: Introduction of LCA – Methodology of LCA – ISO 14044 Significance of LCA – Case studies of LCA .

Text Books :

1. *Bharucha, Erach. Textbook of environmental studies for undergraduate courses. 2nd ed. Universities Press, 2013. ISBN 978-8173718625.*

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Semester-V

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS5001/ BCS5051	Design and Analysis of Algorithms	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	1	4	6
Pre-requisites/Exposure	CSET243				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Examine and Analyze the asymptotic performance of algorithms.
CO2: Explain various algorithmic techniques for solving problems.
CO3: Experiment to find and develop optimal solutions by applying different algorithmic strategies for polynomial and non-polynomial problems.

Course Contents:

UNIT 1: **12 lecture hours**

Introduction to algorithm, What is Time Complexity and Space Complexity, Order of Growth; Approximation; Asymptotic Notations : Big Oh, Theta, Omega, Amortized analysis, Analyzing control statement, Loop Invariant, Recurrence Relations Introduction, Back Substitution Method, Recursion Tree Method, Master's Theorem, Divide and Conquer Algorithm, Multiplying large Integers Problem, Median of two sorted arrays, Binary search, Quick Sort, Merge Sort, Max-Min problem, Strassen's Matrix Multiplication, Radix Sort, Bucket Sort.

UNIT 2: **14 lecture hours**

Greedy Algorithm: General Characteristics, Knapsack Problem, Huffman code, Activity selection problem, Minimum Spanning trees, Prim's algorithm, Kruskal's algorithm with Disjoint sets, Shortest paths: Dijkstra's Algorithm, Graphs Algorithms:- Applications of DFS- bi-connectivity, Topology Sort, Articulation point, Connected components, Max-Flow, Min-Cut, Ford-Fulkerson, Dynamic Programming:- Introduction, Principle of Optimality, Calculating Binomial Coefficient, 0-1 Knapsack, Matrix chain multiplication, Longest Common Subsequence, All Points Shortest path Floyd War shall, Largest Divisible Subset.

UNIT 3: **08 lecture hours**

Backtracking and Branch and Bound: - State-Space Search Tree, eight queen's problem, Graph Coloring, Hamiltonian Cycle, Travelling Salesman Problem using Branch and Bound Approach, String Matching Algorithms, Naive string-matching algorithm, Knuth Morris-Pratt algorithm.

UNIT 4: **08 lecture hours**

Introduction to NP-Completeness: - P and NP, NP Complete and NP-Hard, Approximation algorithms, Travelling Salesman problem, Randomized Algorithms: Randomized Quick Sort, Computational Geometry: Convex hull, Online Algorithms: K Server Problem.

Laboratory:

The students will be implementing the fundamental design paradigms like dynamic paradigm, greedy algorithms, graphs traversing and several others.

Text Books:

1. *Cormen, Thomas H., Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. Introduction to algorithms. 4th ed. MIT press, 2022. ISBN 9780262367505.*
2. *Horowitz, Ellis, Sartaj Sahni, and Sanguthevar Rajasekaran. Computer algorithms C++: C++ and pseudocode versions. 2nd ed. The Orient Blackswan, 2019. ISBN 9386235145.*

Reference Books :

1. Karumanchi, Narasimha. *Algorithm Design Techniques: Recursion, Backtracking, Greedy, Divide and Conquer, and Dynamic Programming*. 1st ed. CareerMonk Publications, 2018. ISBN 978-8193245255.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS5002/ BCS5052	Deep Learning	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To explain the fundamentals of deep learning, Convolution neural network.
CO2: To articulate different problem of classification, detection, segmentation, generation and understand existing solutions/ deep learning architectures.
CO3: To implement a solution for the given problem and improve it using various methods transfer learning, hyperparameter optimization.

Course Contents:

UNIT 1: **08 lecture hours**

Deep Learning and Course Overview, Neural Networks: Perceptron and Biological Inspiration, Building Blocks: Activation Functions and Loss Functions, Optimization I: Gradient Descent and Stochastic Gradient Descent -SGD, Optimization II: Momentum, AdaGrad, RMSprop, Adam, Artificial Neural Network -ANN Architectures and Universal Approximation, Training Neural Networks I: Data Preprocessing, Initialization, Batch Normalization, Training Neural Networks II: Regularization -L2, Dropout, Hyperparameter Tuning, ANNs for Regression Tasks, ANNs for Classification Tasks -Binary and Multi-class, Evaluating Model Performance: Metrics, Bias vs. Variance, Overfitting/Underfitting.

UNIT 2: **10 lecture hours**

Computer Vision and Image Representation, Convolutional Neural Networks -CNNs: Convolution and Pooling Layers, Building CNN Architectures, Training CNNs for Image Classification, Classic CNN Architectures -LeNet, AlexNet, VGG, Modern CNN Architectures -ResNet, Inception, Transfer Learning and Fine-tuning Pre-trained Models, Object Detection I: Concepts and Sliding Windows, Object Detection II: R-CNN, Fast R-CNN, Faster R-CNN, YOLO, Understanding CNNs: Visualization Techniques

UNIT 3: **10 lecture hours**

Sequential Data and Language Models, Recurrent Neural Networks -RNNs and Backpropagation Through Time -BPTT, Addressing Vanishing/Exploding Gradients: LSTMs and GRUs, Bidirectional RNNs/LSTMs/GRUs, Attention Mechanism, Transformer Networks: Architecture and Self-Attention, Applying Transformers: BERT and Large Language Models -LLMs, Core Natural Language Processing -NLP Tasks and Applications

UNIT 4: **08 lecture hours**

Generative Models, Variational Autoencoders -VAEs, Generative Adversarial Networks -GANs, Graph Neural Networks -GNNs, GNN Architectures and Applications

UNIT 5: **06 lectures hours**

MLOps: Lifecycle, CI/CD, Monitoring, Responsible AI: Fairness, Accountability, Transparency, Ethics

Laboratory:

1. PyTorch Fundamentals - Tensors and Autograd
2. Building a Simple Linear Regression Model in PyTorch
3. Implementing an ANN for Binary Classification -e.g., Logistic Regression equivalent
4. Applying Optimizers -Adam, SGD and Observing Convergence
5. Building a CNN for Image Recognition -e.g., MNIST/FashionMNIST
6. Implementing Data Augmentation for Image Data -using torchvision
7. Implementing LSTMs/GRUs for Improved Sequence Modeling
8. Text Classification using a Pre-trained Transformer -Hugging Face integration
9. Implementing a Simple Variational Autoencoder -VAE for Image Generation
10. Graph Neural Networks -GNNs using PyTorch Geometric
11. MLOps: Experiment Tracking with MLflow
12. Responsible AI Toolkit: Fairness/Bias Assessment in Classification

Text Books:

1. *Stuart Russell and Peter Norvig, "Artificial Intelligence a Modern Approach", 2022.*
2. *Charu C. Aggarwal, "Neural Networks and Deep Learning", Springer 2024.*
3. Goodfellow Ian, Yoshua Bengio, Aaron Courville and Yoshua Bengio, *Deep learning. Vol. 1 C*(1st ed.), ambridge: MIT press, 2016. ISBN 978-0262035613

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

4.

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS5003/ BCS5053	AI Assisted Coding and Data Analytics	L	T	P	C
Owning School/Department	Computer Science and Engineering	1	0	4	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Apply AI-assisted tools and techniques in software development, including coding, version control, software design principles, and secure coding practices.

CO2: Use AI-powered tools for data analytics, visualization, statistical analysis, and software testing, and demonstrate their application through a hands-on project.

Course Contents:

UNIT I: **08 lecture hours**

Introduction to AI in software development, AI coding assistants (GitHub Copilot, Tabnine), professional ethics in AI-driven development, software development lifecycle (SDLC), Git basics (repository, commit, branch, merge), centralized vs distributed workflows, AI-assisted Git tools, software design principles (abstraction, modularity, cohesion, coupling), UML class diagrams, secure coding principles, OWASP Top 10 overview.

UNIT II: **06 lecture hours**

Basics of data analytics (data types, preprocessing, cleaning), AI in data analytics (Power BI, Tableau), data visualization with Python (Matplotlib, Seaborn), basic statistical measures (mean, median, standard deviation), AI-assisted exploratory data analysis (EDA), AI-assisted code generation, debugging, unit testing (JUnit, pytest), test-driven development (TDD), hands-on mini project with AI-assisted coding and data analytics.

Laboratory:

1. Environment Setup: GitHub Copilot and VS Code/JetBrains integration
2. Additional AI coding tools and API configurations
3. Prompt Engineering: Improving prompts and context management
4. Advanced Prompt Engineering: Zero-shot, one-shot, and few-shot techniques3
5. Ethical Foundations: responsible AI coding practices
6. AI-Based Code Completion: Working with suggestions for classes, loops, conditionals
7. Error Debugging with AI: Systematic approaches to finding and fixing bugs
8. Test-Driven Development with AI: Generating and working with test cases
9. Documentation Generation: Automatic documentation and code comments
10. Code Review and Quality: Using AI to improve code quality and readability
11. Data Structures with AI: Implementing fundamental structures
12. Algorithms with AI Assistance: Sorting, searching, and optimizing algorithms
13. Code Refactoring: Improving legacy code with AI suggestions
14. Web Frontend Development: AI-assisted HTML/CSS/JS generation
15. Backend API Development: Creating RESTful services with AI

16. Database Design and Queries: Schema design and SQL generation
17. AI for Data Processing: Data cleaning and preprocessing scripts
18. API Integration: Connecting to external services with error handling
19. Code Translation: Converting between programming languages
20. Security Testing: Identifying vulnerabilities in AI-generated code
21. Collaborative AI Coding: Pair programming and version control integration
22. Advanced Ethical Considerations: Addressing complex scenarios and limitations
23. Capstone Project Workshop: End-to-end application development
24. Replit for Mobile Applications

Text Books:

1. *Leo Porter, Daniel Zingaro, "Learn Ai-assisted Python Programming", 2024.*
2. *Tom Taulli, "Ai-Assisted Programming Better Planning, Coding, Testing, and Deployment", 2024.*

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS5004	Cyber Security	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Identify and evaluate cybersecurity threats, vulnerabilities, and risk management strategies in modern computing systems.
CO2: Apply principles of cryptography, network security, and secure software development to protect information assets.
CO3: Analyze cyber incidents and implement defense mechanisms in compliance with legal and ethical standards.

Course Contents:

UNIT 1: **08 lecture hours**

Introduction to Cyber Security, Threats, Vulnerabilities, and Risk Management, Security Frameworks and Threat Modeling, Access Control and Identity Management, Cryptography - Concepts and History, Symmetric Cryptography, Asymmetric Cryptography and PKI, Cryptographic Hash Functions and Applications, Security Policies, Governance and Ethics

UNIT 2: **08 lecture hours**

Network Security Fundamentals, Firewalls and Network Defense, VPNs and Secure Communications, Intrusion Detection and Prevention Systems, Wireless and Mobile Network Security, Cloud Security Architecture, Virtualization and Container Security, DNS and Web Protocol Security, Incident Response for Network Security

UNIT 3: **08 lecture hours**

Secure Software Development Lifecycle, Web Application Security and OWASP Top 10, API Security, Mobile Application Security, Database Security, Secure Coding Practices and Code Review, Malware Analysis and Defense, Application Security Testing, Data Protection and Privacy Technologies

UNIT 4: **08 lecture hours**

Information Security Management Systems, Security Operations Center -SOC Functions, Compliance and Regulatory Frameworks, Security Auditing and Monitoring, Business Continuity and Disaster Recovery, Threat Intelligence and Security Awareness

UNIT 5: **08 lecture hours**

AI and Machine Learning in Cybersecurity, IoT and Embedded Systems Security, Quantum Computing, Blockchain Security

Laboratory:

1. Reconnaissance on a target website using tools like Nmap, Whois, and Google Dorks to gather open-source intelligence
2. Generate secure passwords using OpenSSL and analyze password strength. Use tools like John Ripper for password cracking exercises

3. Implement symmetric -AES/DES and asymmetric -RSA encryption/decryption. Demonstrate hashing -MD5/SHA and digital signatures using tools like Cryptool or Jcrypt
4. Conduct network scanning using Nmap and Zenmap. Perform vulnerability assessment using Nessus or OpenVAS, and generate a security report
5. Capture and analyze network packets using Wireshark. Identify suspicious traffic and extract credentials from unencrypted sessions
6. Configure a firewall -Windows/Linux for rules. Deploy and test an Intrusion Detection System -Snort to detect and log network attacks
7. Use OWASP ZAP or Burp Suite to identify and exploit common web application vulnerabilities such as SQL Injection and Cross-Site Scripting -XSS
8. Analyze wireless network security using tools like Aircrack-ng. Demonstrate Wi-Fi password cracking and countermeasures
9. Analyze malware in a controlled environment. Observe its behavior using Process Monitor and discuss defense mechanisms
10. Perform disk forensics using Autopsy or FTK Imager. Capture and analyze memory dumps for evidence of compromise
11. Simulate a security incident -e.g., ransomware attack. Document steps for detection, containment, eradication, and recovery based on industry frameworks
12. Cloud security by configuring Identity and Access Management -IAM policies in a cloud environment -AWS Educate, Azure, or GCP Free Tier

Text Books:

1. *Nina Godbole and SUNITBelpure, "Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley. 2023.*
2. *B.B.Gupta, D.P.Agrawal, Haoxiang Wang, "Computer and Cyber Security Principles, Algorithm, Applications, and Perspectives", CRC Press, 2022.*

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS5005	Theory of Computation	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Apply formal language models to classify and analyze computational problems.
CO2: Demonstrate understanding of computability, decidability, and Turing machine-based problem solving.
CO3: Evaluate algorithmic complexity and use reductions to analyze NP-complete problems.

Course Contents:

UNIT 1: **12 lecture hours**

Review of sets, strings, languages, alphabets, proofs -induction, contradiction, Deterministic Finite Automata -DFA: Formal definition -Q,Σ,δ,q0,F, state diagrams, language recognition -L-M, Nondeterministic Finite Automata -NFA: epsilon-transitions, acceptance, examples. Comparison with DFAs, Equivalence of NFA and DFA: Subset construction algorithm, proof of equivalence, Regular Expressions -RegEx: Syntax, formal definition of language denoted -L-R, Equivalence of Regular Expressions and Finite Automata: Converting RegEx to NFA, Converting DFA to RegEx -e.g., state elimination or algebraic methods, Non-Regular Languages: Pumping Lemma for Regular Languages: Statement, proof idea, application in proving languages non-regular, Properties of Regular Languages: Closure properties -union, concatenation, Kleene star, complement, intersection - proofs optional/overview; Minimization and Myhill-Nerode Theorem -Concept of unique minimal DFA

UNIT 2: **10 lecture hours**

Context-Free Grammars -CFG: Formal definition -V,T,P,S, derivations -leftmost, rightmost, parse trees. Examples -arithmetic expressions, palindromes, Ambiguity in Grammars and Languages: Definition, examples, implications for parsing and language design, Pushdown Automata -PDA: Formal definition -Q,Σ,Γ,δ,q0,Z0,F, graphical notation, instantaneous descriptions, acceptance by final state and empty stack. Examples, Equivalence of PDAs and CFGs: Constructing a PDA from a given CFG -top-down parsing simulation, Constructing a CFG from a given PDA, Simplification of CFGs and Chomsky Normal Form -CNF: Removing useless symbols, epsilon-productions, UNIT productions. Conversion to CNF. Importance for parsing algorithms -e.g., CYK, Non-Context-Free Languages: Pumping Lemma for Context-Free Languages: application in proving languages non-CFL, Properties of Context-Free Languages: Closure properties -union, concatenation, Kleene star - yes; intersection, complement - no, Parsing concepts -top-down/bottom-up; Mention of Deterministic PDAs and their relation to parser design for programming languages.

UNIT 3: **10 lecture hours**

Turing Machines -TM: Motivation -limits of FA/PDA, formal definition -Q,Σ,Γ,δ,q0,B,F, tape, head, state transitions, instantaneous descriptions, language acceptance, Turing Machine Examples and Design Techniques: Designing TMs for simple tasks, simple arithmetic, string copying, Variants of Turing Machines: Multi-tape TMs, Nondeterministic TMs; Equivalence with standard TM model, Church-Turing Thesis: Definition of "Algorithm", Universality of TMs, Equivalence of computational models -TMs, lambda calculus, modern programming languages, Decidability: decidable and recognizable languages. Decidable problems concerning Regular Languages -e.g., ADFA, EDFA, EQDFA and CFLs -e.g., ACFG, ECFG, Undecidability: Halting Problem -ATM: Proof of undecidability using diagonalization, Implications of Halting Problem: Uncomputability, limits of

automated software verification, virus detection challenges. Co-Turing Recognizability, Reducibility: mapping reductions -L1≤mL2, using reductions to prove undecidability, Examples of Undecidable Problems via Reductions: Proving undecidability of problems like HALTTM, ETM, REGULARTM by reduction from ATM

UNIT 4: **10 lecture hours**

Measuring time and space complexity for Turing Machines, Asymptotic analysis -Big O notation review, difference between complexity and computability, Complexity Class P: Definition -deterministic TM, polynomial time, examples of problems in P -e.g., path finding in graphs, sorting, CFL recognition. polynomial time -tractability, Complexity Class NP: Definition via Nondeterministic TMs -polynomial time or via Verifiers -polynomial verification. problems in NP -SAT, Hamiltonian Path, Clique, Vertex Cover, Polynomial-Time Reductions: Definition -≤p, using reductions to relate problem complexity within P and NP, NP-Completeness: Definition of NP-hard and NP-complete. Significance: hardest problems in NP. Cook-Levin Theorem -statement and importance: SAT is NP-complete, Classic NP-Complete Problems Proving SAT is NP-complete -Cook-Levin proof idea, Showing other problems are NP-complete via reduction from SAT or other known NPC problems -e.g., 3-SAT, Clique, Vertex Cover, Hamiltonian Path, Implications of NP-Completeness: How to deal with NP-hard problems in practice -approximation algorithms, heuristics, fixed-parameter tractability, special cases, P versus NP Problem: Statement, significance -$1M Clay prize, current beliefs -P!= NP widely suspected, consequences if P=NP

Text Books:

1. *Hopcroft H.E. and Ullman J.D, "Introduction to Automata Theory Languages and Computatn", Pearson Education,2023.*
2. *Sipser, "Introduction to Theory of Computation", 2nd Edition Thomson, 2022.*

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS5007	Essence of Indian Knowledge Tradition	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	0
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Understand the foundational concepts, sources, and transmission methods of Indian Knowledge Systems.

CO2: Analyze the contributions of Indian traditions in fields such as science, philosophy, health, governance, and education.

CO3: Evaluate the relevance and application of Indian knowledge traditions in contemporary society and interdisciplinary contexts.

Course Contents:

UNIT 1: **05 lecture hours**

Understanding Indian Knowledge Systems, Modes of Knowledge Transmission in Ancient India, Vedic Corpus: Foundations of Indian Wisdom, Exploring Vedangas and Upavedas, Classical Indian Philosophical Traditions: An Overview

UNIT 2: **05 lecture hours**

Logic and Epistemology in Indian Philosophy, Indian Contributions to Mathematics: From Ancient to Medieval, Advancements in Astronomy and Cosmology in India, Ayurveda: Science of Life and Well-being, Traditional Indian Architecture and Town Planning

UNIT 3: **05 lecture hours**

Language and Knowledge: Role of Sanskrit, Indian Literature and Poetics: Exploring Aesthetics and Meaning, Indigenous Knowledge Systems, Indigenous Knowledge in Environment and Ecology: Practices and Wisdom

UNIT 4: **05 lecture hours**

Art, Music, and Dance in Indian Tradition, Governance and Administration in Ancient India, Ethical and Epistemological Concerns in IKS, Relevance and Future of Indian Knowledge Systems, Constitution of India

UNIT 5: **06 lecture hours**

Constitutionalism and Indian Context, Making of Indian Constitution: Constituent Assembly and Philosophical Foundations, Preamble: Ideals and Objectives of Constitution, Fundamental Rights: Right to Equality, Fundamental Rights: Freedoms and Other Rights

UNIT 6: **05 lecture hours**

Fundamental Rights: Cultural and Educational Rights and Constitutional Remedies, Directive Principles of State Policy: Guiding Principles for Governance, Fundamental Duties and Responsibilities of Citizens, Union Executive: President and Vice-President

UNIT 7: **05 lecture hours**

Union Executive: Prime Minister and Council of Ministers, Union Legislature: Parliament - Lok Sabha and Rajya Sabha, Judiciary: Supreme Court of India, Federalism and Center-State Relations in IndiaState Government: Executive and Legislature

UNIT 8: **06 lecture hours**

State Government: Judiciary and Local Self-Government, Constitutional Amendments and Structure Doctrine, Emergency Provisions and Constitutional Governance, Contemporary Debates and Future of Indian Constitution

Text Books:

1. B.Madhavan,Vinayak Rajat Bhat, Nagendra Pavana R.N. "Introduction to Indian knowledge system", PHI Learning Private Limited,2024.
2. Bhatt, S. R., and Anu Mehrotra. "Philosophy of Education: Indian Perspective", D. K. Print world,2018.

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Semester-VI

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS6001/ BCS6051	High Performance Computing	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Compare and Analyze data parallel and task parallel algorithms and their serial versions for searching and sorting tasks on matrix, tree, and graph data structures.
CO2: Explain distributed memory, message passing modelling and mapping of parallel programs to physical processors.
CO3: Implement serial and parallel algorithms for different applications using HPC libraries.

Course Contents:

UNIT 1: **08 lecture hours**

HPC - Serial vs. Parallel vs. High Throughput, Flynn's Taxonomy. Need of Parallelism, Moore's Law, Power Wall, HPC Architectures: Shared Memory - SMP, NUMA, Distributed Memory - Clusters, Hybrid Systems, Accelerators - GPUs. Memory Hierarchies, Interconnects - Latency/Bandwidth, Parallel Programming Models: Shared Memory - Threads, Distributed Memory - Message Passing, Accelerator Programming, Principles of Parallel Algorithm Design: Decomposition - Task/Data, Mapping, Communication, Synchronization, Load Balancing, Performance Metrics and Analysis Introduction: Speedup, Efficiency, Scalability - Strong/Weak, Amdahl's Law, Gustafson's Law. Profiling Concepts, HPC Environment and Tools: Accessing Clusters, Linux Command Line Essentials for HPC, Schedulers - e.g., Slurm, Compilers - GCC, LLVM, Vendor and Optimization Flags

UNIT 2: **08 lecture hours**

OpenMP: Architecture, Execution Model, Constructs - parallel, for, sections, Work-sharing Constructs: Loop scheduling - static, dynamic, guided, single, master, Data Environment: shared, private, first private, last private, reduction. Data Races and False Sharing, Synchronization: critical, atomic, barrier, ordered, locks, Tasking with OpenMP: task, task wait, task group. Dependencies. Recursive Parallelism, NUMA Architectures and OpenMP: Affinity, Memory Placement - first touch, Bandwidth Considerations. STREAM Benchmark analysis, Vectorization with OpenMP SIMD: simd directive, declare simd, Alignment, Array Notation, OpenMP Performance Analysis and Optimization: Identifying overheads, load imbalance, synchronization costs. Using profilers - e.g., gprof, perf, vendor tools for OpenMP

UNIT 3: **10 lecture hours**

MPI: Architecture, Communicators, Ranks, Processes, Initialization/Finalization, Send/Receive, Point-to-Point Communication I: Blocking Send/Receive - MPI_Send, MPI_Recv, Buffering, Deadlock avoidance, Non-blocking Send/Receive - MPI_Isend, MPI_Irecv, Completion - MPI_Wait, MPI_Test, Communication Modes - Standard, Buffered, Synchronous, Ready. Overlapping Communication/Computation, Collective Communication I: Overview, Broadcast, Scatter, Gather, Reduction Operations - MPI_Reduce, MPI_Allreduce, Scan - MPI_Scan, Barrier - MPI_Barrier, Scatter/Gather Variants - MPI_Allgather, MPI_Alltoall. Non-blocking Collectives, MPI Derived Datatypes: MPI_Type_vector, MPI_Type_contiguous, MPI_Type_struct. Non-contiguous data transfer, MPI Process Topologies: Cartesian and Graph Topologies, MPI Performance Analysis and

Optimization: Communication overhead, Latency/Bandwidth impact, Load balancing strategies. Using profilers - e.g., TAU, Scalasca, vendor tools for MPI, Hybrid MPI+OpenMP Programming: Models and Implementation

UNIT 4: **08 lecture hours**

GPU Architecture - SMs, Warps/Wavefronts, Memory Hierarchy - Global, Shared, Constant, Local, Cache, Host-Device Interaction, CUDA C/C++: Kernel Launch Syntax, Thread Hierarchy - Grid, Block, Thread, CUDA Memory Management: Device Memory Allocation - cudaMalloc, cudaFree, Host-Device Transfers - cudaMemcpy, Unified Memory, Shared Memory for Data Reuse, Synchronization - syncthreads, Matrix Multiplication, Portable GPU Programming: OpenMP Offloading -target, teams distribute parallel for simd, map clause, OpenMP Offloading II: Data Mapping Deep Dive, Asynchronous Operations - nowait, Tasking on GPUs, SYCL - Optional, based on faculty expertise/interest: Concepts, Syntax, Comparison with CUDA/OpenMP Offload, Occupancy, Memory Bandwidth, Coalescing, Divergence. Using GPU profilers - e.g., Nsight Compute/Systems, vendor tools

UNIT 5: **08 lecture hours**

Roofline Model Deep Dive, Advanced Loop Optimizations - Tiling, Fusion, Communication Optimization Techniques, Parallel I/O: Concepts, Parallel File Systems Overview - e.g., Lustre, MPI-IO, Cloud HPC Offerings - AWS/Azure/GCP Overview, Virtual Clusters, Cost Models, Containerization: Docker and Singularity/Apptainer, Reproducibility, Dependency Management

Laboratory:

1. Accessing HPC Cluster and Job Submission
2. Serial Performance Baseline and Profiling
3. OpenMP: Parallel Loops
4. NUMA Effects and Bandwidth Measurement
5. OpenMP SIMD Vectorization
6. MPI: Hello World and Send/Receive
7. MPI Performance Analysis and Profiling
8. CUDA/OpenMP Offload: Vector Addition
9. GPU Performance Analysis
10. Performance Modeling: Roofline Analysis
11. Parallel I/O Introduction
12. Cloud HPC

Text Books:

1. *N. N. Sakhare, S. N. Bhosale, and P. P. Jorvekar - Kumbhar,* "High Performance Computing". *Nirali Prakashan, 2023.*
2. Robey, Robert, and Yuliana Zamora. *Parallel and high-performance computing.* 1 ed. Manning, 2021. ISBN 9781638350385.
3. Sterling, Thomas, Maciej Brodowicz, and Matthew Anderson. *High performance computing: modern systems and practices.* 1 ed. Elsevier Science, 2017. ISBN 9780124202153.

Reference Books :

1. Dimov, Ivan, and Stefka Fidanova, eds. *Advances in High Performance Computing: Results of the International Conference on "High Performance Computing" Borovets, Bulgaria, 2019.* Vol. 902. Springer Nature, 2020. ISBN 9783030553477.

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Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS6003/ BCS6053	Competitive Programming	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	4	5
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To be able to solve a complex problem in given deadline in a competitive setup.
CO2: Find optimal solution by implementing most suitable algorithm.
CO3: Develop logical reasoning, debugging skills, and coding speed through participation in coding challenges and contests.

Course Contents:

UNIT 1: **05 lecture hours**

Review of Asymptotic Analysis and Complexity Trade-offs, Advanced Techniques for Solving Recurrence Relations, Amortized Analysis and its Applications in Data Structures

UNIT 2: **05 lecture hours**

Greedy Approach: Principles, Design, and Applications, Divide and Conquer: Mastering Recursive Problem Decomposition, Dynamic Programming: Core Concepts, Memorization, and Tabulation - Part 1, Dynamic Programming: Core Concepts, Memorization, and Tabulation - Part 2, Backtracking and Exhaustive Search Techniques, Meet-in-the-Middle and Other Problem Reduction Strategies

UNIT 3: **05 lecture hours**

Segment Trees: Range Queries and Updates - Introduction, Segment Trees: Lazy Propagation for Efficient Range Updates, Fenwick Trees - Binary Indexed Trees: Efficient Prefix Sum Computations, Tries - Prefix Trees: Efficient String Storage and Search, Disjoint Set Union - DSU / Union-Find: Managing Connected Components, Advanced Tree Data Structures: Applications Beyond BSTs - e.g., Treaps

UNIT 4: **05 lecture hours**

Revisiting BFS and DFS with Advanced Applications, Shortest Paths Algorithms: Dijkstra's, Bellman-Ford, Floyd-Warshall in Depth, Minimum Spanning Trees: Prim's and Kruskal's Algorithms Revisited, Network Flow Algorithms: Max-Flow Min-Cut Theorem and Applications, Maximum Bipartite Matching and Related Problems, Topological Sort and Strongly Connected Components

UNIT 5: **05 lecture hours**

KMP and Rabin-Karp, Suffix Arrays and Suffix Trees: Concepts and Applications, Advanced String Algorithms: Aho-Corasick and Z-Algorithm

UNIT 6: **04 lecture hours**

Geometric Concepts: Points, Lines, Vectors, and Operations, Convex Hull Algorithms: Graham Scan and Other Techniques, Line Segment Intersection and Polygon Properties

UNIT 7: **04 lecture hours**

Divisibility, GCD, LCM, Prime Numbers, Modular Arithmetic: Operations, Inverses, and Applications, Primality Testing and Factorization

UNIT 8: **05 lecture hours**

Bitwise Operations and Their Applications, Common Bit Manipulation Tricks and Techniques, Bit masking and its Applications in Dynamic Programming

UNIT 9: **04 lecture hours**

Counting: Permutations and Combinations, Binomial Coefficients and Inclusion-Exclusion Principle, Probability and Expected Value

Laboratory:

1. Implementing Greedy Solutions
2. Applying Divide and Conquer Techniques
3. Hands-on Dynamic Programming Challenges
4. Solving Problems with Backtracking and Exhaustive Search
5. Implementing Meet-in-the-Middle Solutions
6. Segment Tree Implementation and Queries, Implementing Lazy Propagation in Segment Trees
7. Practical Exercises with Fenwick Trees -Binary Indexed Trees
8. Building and Utilizing Tries for String Problems
9. Implementing Disjoint Set Union -DSU for Connectivity Problems
10. Exploring Applications of Advanced Tree Data Structures
11. Advanced Applications of BFS and DFS in Graph Problems
12. Implementing and Comparing Shortest Path Algorithms
13. Solving Minimum Spanning Tree Problems using Prim's and Kruskal's Algorithms
14. Implementing Network Flow Algorithms for Max-Flow Problems
15. Solving Maximum Bipartite Matching Problems
16. Applying Topological Sort and Finding Strongly Connected Components
17. Implementing String Matching Algorithms: KMP and Rabin-Karp, Working with Suffix Arrays and Suffix Trees
18. Implementing Advanced String Algorithms: Aho-Corasick and Z-Algorithm
19. Computational Geometry Problems, Implementing Convex Hull Algorithms, Solving Line Segment Intersection and Polygon Property Problems
20. Fundamental Number Theory Concepts, Applying Modular Arithmetic
21. Implementing Primality Testing and Factorization Algorithms
22. Bitwise Operations, Applying Common Bit Manipulation Tricks in Problem Solving
23. Utilizing Bit masking in Dynamic Programming Implementations
24. Permutations and Combinations, Binomial Coefficients and Inclusion-Exclusion Principle

Text Books :

1. Laaksonen, Antti. *Competitive programmer's handbook.* 1st ed. Springer, 2018. ISBN 978-3319725468.
2. Laaksonen, Antti. *Guide to competitive programming*. 1st ed. Springer International Publishing, 2020. ISBN 9783030393577.

Reference Books :

1. Dürr, Christoph, and Jill-Jênn Vie. *Competitive programming in Python: 128 algorithms to develop your coding skills*. 1st ed. Cambridge University Press, 2020. ISBN 9781108716826.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS6004	Compiler Design	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate major phases of compilation.

CO2: To examine various parameters passing scheme, explain memory management of a programming languages and perform code optimization.

CO3: To Implement lexical analyzers, parsers, and small compilers by using general purpose programming languages.

Course Contents:

UNIT 1:

Compiler Design, Lexical Analysis - Introduction and Finite Automata, Lexical Analysis - Implementation, Syntax Analysis - Introduction and Context-Free Grammars, Syntax Analysis - Top-Down Parsing - Recursive Descent, Syntax Analysis - Top-Down Parsing - LL-1 Parsing, Syntax Analysis - Bottom-Up Parsing - Shift-Reduce Parsing, Syntax Analysis - Bottom-Up Parsing - SLR Parsing, Syntax Analysis - Bottom-Up Parsing - CLR and LALR Parsing

UNIT 2:

Semantic Analysis - Symbol Tables, Semantic Analysis - Scope Resolution, Intermediate Code Generation - Introduction, Intermediate Code Generation - Three-Address Code, Intermediate Code Generation - Implementation of Three-Address Code

UNIT 3:

Code Optimization - Introduction and Block Optimization, Code Optimization - Data Flow Analysis, Code Optimization - Loop Optimizations, Code Generation - Instruction Selection and Register Allocation, Code Generation - Target Code Generation and Optimization, Advanced Topics in Compiler Design, Compiler Construction Tools and Techniques, Error Handling and Compiler Diagnostics, Static Analysis and Compiler Optimizations

Text Books:

1. Sunitha, K. V. N., *Compiler construction* (1 ed.), Pearson Education India, 2013. ISBN 978-9332500297.
2. Thain Douglas, *Introduction to Compilers and Language Design* (2 ed.), Lulu.com, 2019. ISBN 978-0359142835.

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Semester-VII

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

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Semester-VIII

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Specialization Core I and II

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS3101/ BCS3151	Statistical Machine Learning	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate key features and methods of Statistical Machine Learning (SML).
CO2: To formulate and design the given application as a statistical machine learning problem.
CO3: To implement and evaluate common statistical machine learning techniques.

Course Contents:

UNIT 1: **7 lecture hours**

Statistical Theory, Supervised Learning, Unsupervised Learning, Data and Types, Feature variable, Machine Learning, Statistics terms, Supervised learning, Concentration inequalities, Generalization bounds, Plugin classifiers, Least-squares methods, Bias vs Variance, Theory of generalization, Understand Underfitting, Overfitting, Parametric methods, Maximum likelihood, Bayes algorithm, Minimax algorithm, Expectation-Maximization, Advantages and Disadvantages, Applications of EM Algorithm, Use case of EM Algorithm.

UNIT 2: **10 lecture hours**

Bayesian versus Non-Bayesian approaches, Density estimation, Gaussian Distributions, Gaussian Mixture Models, Gaussian Discriminant Analysis, Independent Component Analysis, Convexity and Optimization: Convexity, Conjugate functions, Nonparametric classifications methods, Unconstrained optimization, Constrained optimization, Nonparametric methods, KKT conditions, Lagrangian minimization, Primal feasibility, Dual feasibility, Complementary slackness.

UNIT 3: **13 lecture hours**

Basis pursuit, Polynomial Expansion, Feature maps, The "kernel trick", Vapnik-Chervonenkis (VC) dimension, VC generalization bounds, Sparsity: High dimensional data, The role of sparsity, Sparsistency, Consistency, Persistency, Sparsity in nonparametric regression, Sparsity in graphical models, Greedy algorithms, Sparse linear regression, Compressed sensing, Nonparametric Methods: Nonparametric regression, Density estimation, Factor Analysis, Matrix Factorization, The bootstrap, Subsampling, Nonparametric Bayes.

UNIT 4: **12 lecture hours**

Probability Distributions for modelling, Markov Networks, Hidden Markov Model, Advanced Theory: Concentration of measure, Covering numbers, Learning theory, Exact learning (Dana Angluin), Probably approximately correct learning (PAC learning), VC theory (Vladimir Vapnik and Alexey Chervonenkis), Risk minimization and its approaches, Bundle Methods, Graph Analytics, Graph-based machine learning algorithms, Simulation methods, Variational methods, Tsybakov noise conditions, Surrogate loss functions, Minimax rates for classification, Minimax rates for regression, Manifold methods, Spectral methods.

Laboratory:

Students will gain practical experience with the implementation of different statistical methods by using different statistical machine learning tools. Eventually, the lab works formulate the problem as a statistical machine learning problem followed by its implementation.

Text Books:

1. *Masashi Sugiyama, Introduction to Statistical Machine Learning on (1st ed.), Morgan Kaufmann, 2017. ISBN 978-0128021217.*
2. *T. M. Mitchell, Machine Learning (1st ed.), McGraw Hill, 2017. ISBN 978-1259096952.*

Reference Books

1. Richard Golden, *Statistical Machine Learning A Unified Framework* (1st ed.), CRC Press 2020. ISBN 9781351051490.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS4101/ BCS4151	Intelligent Model Design using AI	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate key features of various Machine learning and Deep Learning tools for Intelligent Modelling.

CO2: To examine and implement intelligent applications using Machine Learning and Deep Learning tools.

CO3: To implement Machine Learning and Deep Learning models for design thinking and evaluate them using relevant metrics.

Course Contents:

UNIT 1: **8 lecture hours**

Why Intelligent Model? Intelligent Citizens of the World, Thinking More Clearly, Empathize, Define, Ideate, Prototype, Test, Using and Understanding Data, Using Models to Decide, Strategize, and Design, Automation/Augmentation Opport UNITies, AI in Sensitive Applications, AI in Healthcare and Security, Pervasive, AI Systems, AI in IOT Devices, Business Value of Data: Case Study on Data Dependent Company, Data Valuation, Data Quality, Data Driven Marketing and Commerce, Biases in AI Models, Handling Gender, Race, Religion, Cultural Biases, Unintended Biases.

UNIT 2: **10 lecture hours**

User privacy, Data Privacy aware AI, Data Sharing Regulations, AI Model Security, Attacks on AI models, Adversarial Attack, Relevance Feedback, Adaptive Learning, Online learning, Model fine-tuning, Transfer Learning, Domain Adaption, Explainable AI, ML Accountability and Fairness, Model Interpretation, Class imbalance in Modelling, Handling Data Drift, Human- Machine Co-learning.

UNIT 3: **12 lecture hours**

Aligning Mental and Machine Learning Models, Coding Automation, Rapid Prototyping in AI, Market Demand Analysis, Automated Requirement Analysis, Customer opinion analysis, Attribute based opinion mining, Geospatial Analytics, Spatial analysis, Spatial-temporal analysis, Geo-clustering, Market Segmentation, Demographic, Cultural, Behavioral and Psychographic Segmentation, Dynamic Pricing, Price Optimization, Personalization, Recommender Systems, Feature Attribution, SHAP (SHapley Additive exPlanations), Lime, Shapash, Dalex.

UNIT 4: **12 lecture hours**

Speed vs Accuracy Trade-off, optimizing models for resource constrained devices, Deep Learning Model compression, Pruning, Low-rank factorization, Automatic Machine Learning, Neural Architecture Search, Deploying Machine Learning Models, Staging Automation, Cognitive Modelling, Conversational Systems, Data driven persona, User personas, Reasoning Under Uncertainty, Multi-agent System, Reinforcement Learning, General Intelligence, Super Intelligence, Decision Making Systems.

Laboratory:

Students will gain practical experience with the implementation of different intelligent methods. The lab work consists of exploratory data analysis using tools, libraries and python programming language by using Machine Learning and Deep Learning models.

Text Books:

1. *Aggarwal C. C., Neural Networks and Deep Learning on (1st ed.), Springer International, 2018. ISBN 978-3030068561.*

Reference Books :

1. Kasparov Garry, *Mig Greengard, Deep Thinking*: Where on Machine Intelligence Ends and Human Creativity Begins (1st ed.), John Murray, 2018. ISBN 978-1473653511.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS3102/ BCS3152	Data Analysis using Python	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate the structured and unstructured data for extracting useful information.

CO2: To work with data through visualization and distributions.

CO3: To make use of real-world datasets utilizing various numerical libraries.

Course Contents:

UNIT 1: **14 lecture hours**

Purpose of data analysis, Structured and Unstructured data, Steps of data analysis, Python Packages for Data Analysis: Numpy, Scipy, Matplotlib, Plotyly, NLTK. Data Frames, Usage of frames analytical roles, File handling and reading data for processing, Pre-processing data using multiple python frameworks, Data Formatting, Data Manipulation, Data normalization, Data Merging, Data reshaping, Data Wrangling, Missing value handling, Aggregation function, Data reporting, Data Scrapping using beautiful soup.

UNIT 2: **14 lecture hours**

String Manipulations, Demonstrating string functions, A regular expression for data, manipulation, Data Visualization, Using Histograms, Using Boxplots, Plotting data, Venn Diagram, Bar Chart, Pie Chart, Line Chart, Scatter Plots and R2, Grouped charts, Area Charts, Descriptive Statistics, Central tendencies, Analyzing variability, Data Distributions, Random Variables, Bernoulli Distribution, Binomial Distribution, Normal Distribution, Z score, Statistical Properties, Standard Normal Distribution, Correlation: Pearson correlation method.

UNIT 3: **14 lecture hours**

Exponential distribution, Statistical test, Hypothesis testing, Z-test, Right-tailed test, Two-tailed test, T-Test, Significance of p-value in t-test, Two-sample Z-test, Paired t-test, Introduction to machine learning system, overview of prediction methods, models for classification problems, Sample implementation of machine learning methods on standard datasets, recent start ups based on data analysis, social impact of data analysis.

Laboratory:

Studio work focuses on Different Data Analysis Methods, Techniques, Algorithms using Python Data manipulation using numpy and scipy. Make use of numpy arrays, matrices, indexing and slicing options with the demonstration of numerical packages for data analysis.

Text Books:

1. *Motwani, Bharti. "Data Analytics using Python." (2020). ISBN 8126502959.*
2. *Klosterman, Stephen. Data Science Projects with Python: A case study approach to successful data science projects using Python, pandas, and scikit-learn. Packt Publishing Ltd, 2019. ISBN 978-1838551025.*

Reference Books:

1. Mukhiya, Suresh Kumar, and Usman Ahmed. *Hands-On Exploratory Data Analysis with Python: Perform EDA techniques to understand, summarize, and investigate your data*. Packt Publishing Ltd, 2020. ISBN 9781789537253.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS4102/ BCS4152	Data Mining and Predictive Modelling	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate data preparation for data mining and analyzing based on pre-processing techniques.
CO2: To examine predictive analysis in various use cases.
CO3: To make use of exploratory data analysis to gain insights and prepare data for predictive modelling.

Course Contents:

UNIT 1: **11 lecture hours**

Purpose of Data mining, Procedures of Data Mining, Functionality of Data Mining, Knowledge data discovery process, Data and attribute type, Properties of data, Discrete and continuous attribute, Dataset types, Data quality measurement, Noise Analysis and its importance, Techniques of Data pre-processing, Aggregation, Sampling, Curse of dimensionality, Dimensionality reduction, Feature selection and generation, Discretization and vectorization, Binarization, Attribute transformation correlation, Association rule mining, Apriori algorithm, Rule generation, Pattern Mining in: Multilevel, Multidimensional Space Pattern Mining .

UNIT 2: **07 lecture hours**

Rule-based reasoning, Memory-based reasoning, measuring data similarity, Similarity Metrics: Distance based measure, Information based measures, Set similarity measure, Jaccard Index, Sorenson Dice Coefficient, Model Selection Problem, Error Analysis, Case study, Startups in Data Analysis.

UNIT 3: **10 lecture hours**

Outlier analysis in classification and clustering, Probabilistic models for clustering, clustering high dimensional data: Subspace clustering, Projection Based clustering, Exploratory data analysis, Data summarization and visualization, Dataset exploration, Data Exploration Tools, Interactive Data Exploration, Predictive models, Design Principles, Parametric Models, Non-Parametric Models, ANOVA, Regression Analysis, Frequent Pattern Mining, Mining Closed and Max Patterns.

UNIT 4: **14 lecture hours**

Linear discriminant analysis, Fisher discriminant analysis, Time series Model: ARMA, ARIMA, ARFIMA, Factor Analysis, Uncertainty quantification, Forward uncertainty propagation, Inverse uncertainty quantification, Non-Negative Matrix Factorization, Sequential Matrix Factorization. Exact Matrix Factorization, Expert Lecture from Industry, Recommendation System and Collaborative Filtering, Multidimensional Scaling, Mining Textual Data, Temporal mining, Spatial mining, Visual and audio data mining, Ubiquitous and invisible data mining- Privacy, Security, Social Impacts of data mining.

Laboratory:

Data pre-processing and vectorization. Quality analysis of data. Feature selection and Ranking. Association rule mining and implementation of the Apriori algorithm. Data Similarity and set similarity. Error analysis and model selection. Frequent pattern mining and regression. Discriminant Analysis. Factor Analysis. Matrix Factorization. Recommendation System.

Text Books:

1. *Bruce Ratner, Statistical and Machine-Learning Data Mining: Techniques for Better Predictive Modeling and Analysis (3rd ed.), Chapman and Hall/CRC, 2017. ISBN 978-1498797603.*
2. *Dursun Delen, Predictive Analytics (1st ed.), Knime, 2020. ISBN 9780136738516.*

Reference Books :

1. Mohammed J. Zaki and Wagner Meira, Jr, *Data Minimg and Machine Learning* (1st ed.), Cambridge University Press, 2020. ISBN 9781108473989 .

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS3103/ BCS3153	Cloud Computing	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate cloud computing principles and their business need.
CO2: To identify the design principles of virtualization techniques in cloud resource management.
CO3: To design and development of cloud architectural solution with its detailed monitoring.

Course Contents:

UNIT 1: **11 lecture hours**

Cloud Computing, Adoption of cloud-based IT resources, Service Models: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS), Deployment models: Public Cloud, Private Cloud, Hybrid Cloud, CommUNITy Cloud, Cloud Computing Characteristics, Challenges of cloud computing, Virtualization concept, Types of virtualizations, Demo of virtualization, Virtualization Merits, Role of virtualization in cloud computing, Virtualization Demerits, VM Placement, VM Migration, VM Migration Demo, VM clustering, Design Issues in VM Clustering, Need of Dockers and Containers, Docker Eco-System, Hypervisor vs Docker.

UNIT 2: **12 lecture hours**

Microservices, Service-Oriented Architecture, REST API, IP Addressing, Subnetting, Super netting, Designing of Virtual Private Cloud, Demo of VPC, VPC Peering, VPC Case Study, Cloud Storage, Serverless Computing, Cloud API Gateway, Cloud Databases, Resource Provisioning, Time shared and space shared, Efficient VM Consolidation on cloud server, Task/DAG Scheduling Algorithms, Min-Min, Max-Min, MET, B-level Demo, T-level Demo, Task-VM Mapping, Auto Scaling, Load Balancing.

UNIT 3: **10 lecture hours**

Case Study: Cloud Market analysis, Security and Compliances, Shared security model in IAAS/PAAS/SAAS, Shared technology issues, Data loss or leakage, Account or service hijacking, Implementation of cloud security, Security Groups, Network Access Control Lists, Cloud databases, Parallel Query Execution with NoSQL Database, Big Data, Handling Big Data on Cloud Platform, Map- Reduce framework for large clusters using Hadoop, Design of data applications based on Map Reduce in Apache Hadoop.

UNIT 4: **9 lecture hours**

Comparative study/analysis of public clouds, Edge Computing, Fog Computing, Data Offloading, Cloud-Based DevOps Tools, Task Partitioning, Data Partitioning, Data Synchronization, Distributed File System, Data center, Ongoing Research Topics.

Laboratory:

Practical experience on global cloud infrastructure by performing experiments on Amazon Web Services (AWS), Google Cloud Platform (GCP) and Microsoft Azure platform. The essential services and their hands-on is compulsory on Core IaaS, PaaS and SaaS.

Text Books:

1. *Wang L., Rajiv Ranjan, Jinjun Chen and Boualem Benatallah, Cloud Computing (1st ed.), CRC Press, 2017. ISBN 978-1351833097.*

2. *Hurwitz J. S. and Daniel Kirsch, Cloud Computing For Dummies (2nd ed.), Hoboken: John Wiley & Sons, 2020. ISBN 978-1119546658.*

Reference Books :

2. Sharma Prerna, Moolchan Sharma and Mohamed Elhoseny, *Applications of Cloud Computing* (1st ed.), CRC Press, 2020. ISBN 9780367904128.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS3104/ BCS3154	DevOps Practices and Principles	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate DevOps engineering and DevOps terminologies to meet the business requirements.
CO2: To construct different applications of DevOps that can be used on different platforms.
CO3: To design and execute projects using different tools, UNITs, and templates.

Course Contents:

UNIT 1: **12 lecture hours**

Why DevOps? , Terminologies, DevOps Stakeholders and roles, DevOps Perspective: People, Process and Product, Building Teams, Boston Consultancy Group (BCG) Matrix, Three Horizons Model, Autonomous Team and its Pros and Cons, Autonomy Criteria, Decoupling Point for Autonomous Team, Case Study on Autonomous Team, DevOps and ISTM (IT Service and Management), Traditional Vs Agile DevOps, DevOps Phases with diagram representation, Introduction of Source and Version Control(SVC), Algorithms for SVC: Lock-Modify-Unlock and Copy-Modify -Merge, Continuous Integration, and Deployment (CICD), Software Craftsmanship, Software Containerization, System Provisioning, and Configuration Management, Testing and Test Automation.

UNIT 2: **11 lecture hours**

Service-Oriented Architecture and Microservices, Build and Release Management, Virtual Systems, Hypervisor Cloud Computing, Need of Cloud Computing with Application, Delivery Models of Cloud Computing, Deployment Model of Cloud Computing, Git Desktop Usage, and Benefits, Connecting Git Desktop and Git Online, Git Version Control, and Types, Distributed Version Control Systems with Example, Centralized Version Control Systems with Example, Configuration Management, Chef Configuration, Workstation Setup, Configuration of the knife, Test Connection between Knife and Workstation, Organization Setup, Creation and Connection of Node to Organization, Operations on Node, Object and Search, Creation of Environments and Connecting them with Servers.

UNIT 3: **6 lecture hours**

Puppet, Puppet Working and Architecture, Master and Agents in Puppets, Installing Puppet, Configuring Puppet Master and Agent, Connecting Agents, Puppet Language, Declarative Language, Resources, Files, Exec, Packages, Service in Puppets, Virtual Resources and Exported Resources.

UNIT 4: **13 lecture hours**

DevOps Security, Issues in DevOps Security, DevOps Security Needs and Challenges, DevOps Risks Management, Strategies, Policies, Practices for DevOps Security, DevOps Security Tools, DevOps security over Clouds, Security Models, and their Use, UNITs and Templates for DevOps, DevOps Manifests, Class Templates Static and Dynamic Content, ERB UNIT, NTP UNIT, SSH UNIT, Sudo UNIT, Install LAMP with pre-existing UNITs.

Laboratory:

The Studio work includes the practical understanding of multiple tools and languages that are used in DevOps Industry. DevOps practices aims at merging development, quality assurance, and operations (deployment and integration) into a single, continuous set of processes.

Text Books :

1. *Reed Mark, DevOps: The Ultimate Beginners Guide to Learn DevOps Step-by-Step (1st ed.), Publishing Factory, 2020. ISBN 978-1647710941.*
2. *Gene Kim, Kevin Behr, and George Spafford, The Phoenix Project (5th ed.), IT Revolution Press, 2019. ISBN 978- 1942788294.*

Reference Books :

1. Gene Kim and John Willis, *Beyond the Phoenix Project: The Origins and Evolution of DevOps* (1st ed.), IT Revolution Press, 2018. ISBN 978-1942788256.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	**Bachelor of Technology (Computer Science and Engineering)**				
BCS4103/ BCS4153	**Programming Methodologies for Backend Development**	L	T	P	C
Owning School/Department	**Computer Science and Engineering**	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate the client-Server architecture and the basics of back-end technologies and tools.
CO2: To examine server-side programming languages like PHP and Node.js.
CO3: To connect with database with the help of server-side scripting-PHP and MySQL, Node.js and MongoDB.

Course Contents:

UNIT 1: **12 lecture hours**

Back-end technologies: servers, applications, and databases, Object-oriented based backend programming languages: PHP, Java, Node.js. MERN Stack: Mongo DB, Express.js, React.js, Node.js. functional-based backend programming languages (Mongo DB), Databases, MySQL, XHTML, PHP-a scripting language. PHP: server-side scripting and its syntax, working with variable and constant, PHP code blocks: arrays, strings, function. PHP error handling and Controlling program flow, looping, and branching, file handling, directories, PHP sessions and security, processing forms on server-side, cookies, Web services, exploring Java-based web technologies: JDBC, servlet, JSP. Web architecture model: client-server model, three-tier model, and service-oriented architecture (SOR), MVC architecture: model, view, controller.

UNIT 2: **7 lecture hours**

Database programming: Operations and working on metadata, database configuration, connection to MySQL server, execution of MySQL queries, Node.js: Web Applications with Node.js, Core Node.js and Packages, Events Streams, UNITs: export, object, class. Loading UNIT from a separate folder, File Systems. MongoDB, Features of MongoDB, MongoDB Database Tier, using Node.js with MongoDB, using Node.js with MySQL, Server-side rendering.

UNIT 3: **9 lecture hours**

REPL environment and commands, Backend frameworks: Django, Spring, Express. Docker Containers, GraphQL integration, API documentation: Swagger API, Postman (API testing), REST Principles for API, Containerize APIs with Docker, Serverless computing, DevOps toolkit.

Laboratory:

Practical experience of server-side programming languages like PHP and Node.js by connecting with database with the help of server-side scripting-PHP and MySQL, Node.js, and MongoDB.

Text Books:

1. *Herron David, Node.js Web Development: Server-side web development made easy with Node using practical examples (5th ed.), Packt Publishing Limited, 2020. ISBN 978-1838987572.*

Reference Books :

1. Zammetti Frank, *Modern Full-Stack Development: Using TypeScript, React, Node.js, Webpack, and Docker* (1st ed.), Apress, 2020. ISBN 978- 1484257371

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS4104/ BCS4154	Design of Cloud Architectural Solutions	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To learn stack of cloud architecture and design guidelines of the final product.
CO2: To build the cloud architectural blueprint for deployment.
CO3: To deploy and implement cloud architectural designed solution.

Course Contents:

UNIT 1: **11 lecture hours**

Cloud Architecture Job roles, Solution Architect Certifications, Cloud Solution Architect Competitions, Cloud Computing with characteristics, Core Cloud Services, Loose Coupling, Loose Coupling Strategies, Communication in coupled components, Decoupling of Infrastructure, Scalable Web Application deployment, Multi-Tenancy, Resource Provisioning, Traffic / Demand Monitoring, Capacity Planning and Prediction, Data centre management, Costing and Pricing of public cloud services, Cloud Governing Rules, Cloud Privacy issues, Design Principles for using cloud services, Design Principles for providing cloud services, Cloud architectural design principles, Principles of the Security, Principles of the Reliability Pillar, Principles of the Performance Efficiency Pillar, Cost Optimization, High-Availability Design Patterns, Criteria for cloud service selection, Multi-criteria Decision Making, Cloud Infrastructure security, IAM user, group, roles, and policy.

UNIT 2: **11 lecture hours**

Cloud compliances, Authentication protocol implementation, Content Delivery, Domain name System, Content delivery network, CDN Demo, Traditional network architecture, SDN architecture, SDN controller, OpenFlow protocol, Demo of SDN, Discussion of related Start-up, Traditional infrastructure, Virtual infrastructure, Converged infrastructure, IoT-Cloud Infrastructure, Autoscaling, Launch configuration, Autoscaling groups, ASG Balancing, Autoscaling policies, Load Balancer, Fault tolerance, High availability, Architectural need of LB, Application LB, Network LB, Listener, Target groups, Targets, Cross zone load balancing.

UNIT 3: **9 lecture hours**

Case Study of a federated cloud, Mobile "backend" as a service (MBaaS), Serverless computing, Business Processing as a service (BPaaS), Virtualization Demo vs Containerization Demo, Virtualization and Containerization, Virtualized Operating Systems, Resource to OS-Hypervisor communication, Design of virtualized Database Clusters, Cloud Regional Backbone Networks, Network Troubleshooting, Transcoding and Serving Video Files Example, Stream Processing Example, Sensor Network Data Ingestion and Processing Example, Application Backend Example.

UNIT 4: **11 lecture hours**

Cloud Monolith Applications, Cloudna-tive Applications, Cloud Enterprise Applications, Challenges towards Hypergrowth of cloudna-tive applications, Evolution of Deployment, Current Cloud Computing System Designs, Modern Cloud Architecture Integration, Structure of a Cloudna-tive Application, Characteristics of Cloudna-tive Application, Bridging DevOps Culture with cloud architectural solution, Software development on cloud PaaS, Microservices, Microservice Architecture, Microservice Architecture v/s Monolith Architecture, Developing Cloudna-tive Applications using Microservices, Flexibility and Scalability in microservice, Pros and Cons of Cloud native Architecture, Microservice

Use Cases, Service Decomposition, Microservice Demo, Strategies for Decomposing a System into Microservice, Migrating Monolithic Solutions to Microservice Ecosystem, Minimizing Dependency to Monolithic Solutions, Orchestration / Choreography of Micro-Services, Shared Data and Communication, Case Study on Cloudna-tive Development, Advanced

Laboratory:

Studio works include Hands-on experience on public industry cloud platform and will provide the cloud-based solution for the business problems. The activities that are mandatory to be completed includes troubleshooting the errors, accessing various AWS/Azure/GCP Support Options, using compute, storage, database, and networking concepts to improve the architecture's performance, identify design principles that can help cloud user to achieve performance efficiency, Evaluate the most important performance metrics for any applications. Research Topics.

Text Books:

1. *Goessling Scott and Kevin Jackson, Architecting Cloud Computing Solutions: Build cloud strategies that align technology and economics while effectively managing risk (1st ed.), Packt Publishing, 2018. ISBN 978-1788472425.*

Reference Books :

1. Bahga Arshdeep and Vijay Madisetti, *Cloud Computing Solutions Architect: A Hands-On Approach* (1st ed.), Vpt, 2019. ISBN 978194997801X .

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS3105/ BCS3155	Linux and Shell Programming	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate Linux commands that are used to manipulate system operations at an admin level.
CO2: To write Shell Programming using Linux commands.
CO3: To design and write applications to manipulate internal kernel-level Linux File systems.

Course Contents:

UNIT 1: **8 lecture hours**

Linux and Linux utilities, Architecture of Linux, features of Linux, Introduction to vi editor, Linux commands, File handling utilities, security by file permissions, process utilities, disk utilities, Networking commands, Text processing utilities, backup utilities, User management.

UNIT 2: **8 lecture hours**

Shells need and types, Derived Operators, Linux session, Standard streams, Redirection, Pipes, Tee command, command execution, command-line editing, Quotes, command substitution, job control, aliases, variables, shell/environment customization, Filters, and pipes, File operations.

UNIT 3: **12 lecture hours**

Grep Operation, Grep Commands, Grep Address, Grep Application, Seed Scripts, operation, Unix file structure, File descriptors, System calls and device drivers, File management, File structures, System calls for file management, Directory API, Process and Process Structure, Process table, Viewing processes, System processes, Process scheduling, zombie processes, orphan process,Fork and its operation, Signals functions, unreliable signals, interrupted system calls, Signal sets, File locking, Threats and Vulnerabilities analysis of Linux- direct, indirect, veiled, conditional, Security Measures in Linux-SSH key pair, Scan Log files , Close Hidden ports, Linux Malwares-Botnets, Ransomware, Rootkits, Socket, Socket communications, UDP, TCP, AWK, Shell Scripting and Security- Password Tester, Permissions and Access Control Lists, Shell Scripting for DevOps- Using environment variables, Bash Script.

Laboratory:

Students will use LINUX / UBUNTU to gain hands-on experience on LINUX and Shell programming, Linux commands, their uses and practice, editors: vi, nano etc, Introduction to Shell, Shell basic commands, variables Shell programming environments- filters and pipe, Shell programming File handling, Grep its use and commands. Using of Grep with pipe and filters, Unix file structuring, inodes and related system calls. File handling commands and API, Network Penetration testing tools, Wireshark, Nmap, Hash cat, Process management, creation, termination and other useful commands, Process scheduling. Parent, zombie and orphan process, Process system calls. Fork, exec, wait and signal, various commands. Basics of Socket Programming via UDP socket.

Text Books:

1. *Mallett, Andrew. Mastering Linux Shell Scripting. Packt Publishing Ltd, 2018. ISBN 978-17889905542.*

2. *Blum, Richard. Linux command line and shell scripting bible. Vol. 481. John Wiley & Sons, 2008 ISBN 9781119700930.*

Reference Books:

1. Stevens, W. Richard. *UNIX network programming. Volume 2: Interprocess communications*. Prentice hall, 1999. ISBN 9788120307490.
2. IMRAN, BASHIR. "MASTERING BLOCKCHAIN: distributed ledger technology, decentralization, and smart contracts explained, ; distributed ledger.". ISBN 978-1788839044.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS4105/ BCS4155	System and Network Security	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate the system vulnerabilities, exploitation, and defense mechanisms.
CO2: To examine the spyware, security issues and different types of attacks.
CO3: To do programming for system and mobile security.

Course Contents:

UNIT 1: **11 lecture hours**

Threats and Vulnerabilities of Windows, Threats and Vulnerabilities of Linux, Controls, Risk Management, Basics of Confidentiality, Integrity and Availability, Generic Security Policies, Security Mechanisms, Assurance, Prevention, and Detection, Security Issues in Windows Operating System (Windows XP, Windows Vista, Windows 7 and Windows 10), Linux Kernel TCP/IP Vulnerabilities, TCP SACKs (25), SACK Panic, Mitigation Schemes and Patches Developed for Each Security Issue, Boot Loader Security Issues, Grub Security Flaw.

UNIT 2: **9 lecture hours**

Security in Broadcast Networks, Security in Centralized Networks, DDOS Attacks, Volume-based DDoS attacks, Protocol attacks, Application-layer DDoS attacks, Introduction to Malicious Software's-Botnet, Logical Bombs, Grayware, Spyware, Adware, File Binders, Antivirus, Honeypot, Trapdoor, Latest Malwares Definitions and Their Defense Mechanisms. Android-based Malwares and their Security Patches.

UNIT 3: **9 lecture hours**

Introduction to Network Security, Network-based Attacks, Active and Passive Attacks, Phishing and Its Types, Tailgating, Impersonation, Dumpster Diving, Shoulder Surfing, Hoax, Waterhole Attacks, Denial of Service Attacks and its Types, Man in the Middle Attack, Buffer Overflow Attack, Cross-Site Scripting, SQL Injection Attack, Privilege Escalation, Man in the Browser, Zero-Day Attack, SQL Injection Attack, Privilege Escalation, Man in the Browser.

UNIT 4: **13 lecture hours**

Generic Security Software's, Windows Firewalls, Linux Firewalls, Access Control Lists of Firewalls, Types and Examples of Firewalls, Network-based Honeypots and Trapdoors, Virtual Private Network and its Implementation, Network Intrusion Detection System, Network Intrusion Prevention System, Router Security, Switch Security, Proxy Server and its Configurations, Load Balancers, IPv6 and IPv6 Security, Secure Forwarding in Overlay Networks.

Laboratory:

The lab component is meant to analyses various network security-related concepts and deals with launching different types of attacks and creating a network blueprint of an organization

Text Books :

1. *R. Bragg et al, Network Security: The Complete Reference (1st ed.), TMH Publications, 2017. ISBN 978- 0070586710.*

2. *W. Stallings, Network Security Essentials: Applications and Standards (3rd ed.), Pearson, 2018. ISBN 978-0132380331.*

Reference Books :

1. Joseph Migga Kizza, *Guide to Computer Network Security,* (5th ed.), Springer. 2020. ISBN 978303038140.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS3106/ BCS3156	Microcontrollers, Robotics & Embedded Systems	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To explain the micro-controllers, robotics, embedded system, and their applicability.

CO2: To build the various robots using Robot Operating System.

CO3: To implement the various Embedded system using microcontrollers and ROS.

Course Content:

UNIT 1: **6 lecture hours**

Application of Microcontrollers, Why Embedded system, Application of Robotics, Arduino: Architecture, Serial Port, Serial Communication, Device control using Serial Communication, Arduino Sensors (Humidity, Temperature, Water Detector, Ultrasonic, LDR), Arduino secondary Integration (Relay, DC, Servo motors, RF UNITs), Pulse width modulation (PWM), I2C communication protocol, BH1750: Digital light sensor, Parallel Communication, Arduino UART, GSM, GPRS UNIT.

UNIT 2: **6 lecture hours**

Raspberry Pi: Architecture, Raspberry Pi Port Identification, Raspberry Pi GPIO, Transistorized Switching, Accepting Digital Input on Raspberry Pi, Enabling I2C to Raspberry Pi, Analog, and Digital sensors, BMP180 with Pi, Sensors Interface with Pi LDR, Sensors Interface with Pi DHTT11, Sensors Interface with Pi using Sense HAT.

UNIT 3: **9 lecture hours**

Fundamentals of Robotics, Robot Operating System (ROS), ROS Essentials: ROS Topics, ROS: Services, Actions, Nodes, Build Robot Environment, Unified Robot Description Format (URDF), ROS parameter server, ROS Services, and parameters, Recording and playing back, readingmessages from a bag file, using rosed to edit files in ROS, ROS msg and srv.

UNIT 4: **7 lecture hours**

Simple Publisher and Subscriber, Examining the Simple Publisher and Subscribe, Simple Service and Client, Examining the Simple Service and Client, Motion in ROS (ROS Noetic), Working with Pluginlib, Nodelets, and Gazebo Plugins, Robot Navigation (moveit), Grasping, Grasping using MoveIt, creating a pick and place task, Grasping in the Real Robot, ROS Controllers and Visualization Plugins.

UNIT 5: **9 lecture hours**

Fundamentals of Robotics, Robot Operating System (ROS), ROS Essentials: ROS Topics, ROS: Services, Actions, Nodes, Build Robot Environment, Unified Robot Description Format (URDF), ROS parameter server, ROS Services, and parameters, Recording and playing back, readingmessages from a bag file, using rosed to edit files in ROS, ROS msg and srv.

Laboratory:

Studio work focuses to develop different kind of robots starting from object detection robot, line follower robot. It also consists of introduction to well exist robots such NAO, SOFIA, Pepper.

Text Books:

1. *Newman, Wyatt. A systematic approach to learning robot programming with ROS. CRC Press, 2017. ISBN 9781498777827.*

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS3107/ BCS3157	IoT Networks and Protocols	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs):

On completion of this course, the students will be able to:

CO1: To articulate the protocols and standards designed for IoT.
CO2: To examine the basic protocols IoT and WSN.
CO3: To implement IoT solutions using sensors, actuators, and Devices.

Course Contents:

UNIT 1: **09 lecture hours**

Internet of Things, Sensors, Hysteresis Error, Quantization error, aliasing error, Actuator, Actuations, IoT Networking, Functional components of IoT, IoT dependencies, IoT service-oriented architecture, IoT categories, IoT gateways, Associated technologies, technical derivation from the regular web, IoT protocols, MQTT, SMQTT, CoAP, XMPP, IEEE802.15.4, AMQP.

UNIT 2: **08 lecture hours**

6LoWPAN, LoRAWAN and Reference model, Integration of devices using LoRAWAN, Security in LoRAWAN, Zigbee, 3GPP, NB-IoT, Wireless HART, RFID, ISA100, Z-Wave, WSN, Cluster formation of sensors in WSN, Routing algorithms in WSN, UAV Network, UAV Navigation, 5G based communication among UAVs.

UNIT 3: **06 lecture hours**

Machine to Machine communication, Architecture, and components for M2M, Standardization Effort for M2M, Interoperability in IoT, IoT Architecture for Interoperability, Industry Standards, SDN Origins and Evolution, Centralized and Distributed Control, Data Planes, Genesis of SDN, API in SDN, Control mechanism, Switch Deployment, Controller configuration software, SDNfor WSNs, SDN-WISE Sensor Nodes, SDN-WISE Protocol Structure, Topology in SDN-WISE.

UNIT 4: **05 lecture hours**

Software-Defined WSN Prototype, Situation-Aware Protocol Switching in SDN, Performance Analysis of Software Defined Networks, Sensor cloud, Architecture, Service life cycle model, Layered structure, Management issues in sensor cloud, Optimal composition of virtual sensors, Formation of virtual sensor group.

Laboratory:

Studio works aim to provide hands-on experience of IoT devices to understand the communication part between the devices. Here, we are sending the data using different communication devices such as WiFi, Zigbee and Bluetooth. There are a set of experiments over web layer protocols such as MQTT, HTTP and CoAP. This course is also having projects to solve a real-life problem by using IoT networks and protocols.

Text Books:

1. *David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton and Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things (1st ed.), Cisco Press, 2017. ISBN 1587144565.*

Reference Books:

1. S. Misra, A. Mukherjee and A. Roy, *Introduction to IoT* (1st ed.), Cambridge UniversityPress, 2021. ISBN 1108959741.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCS4106/ BCS4156	Robotics: Dynamics and Controls	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To explain algorithmic approaches, mathematical models, and motion control methods applicable to robotic manipulators.

CO2: To examine computational systems concerning manipulators.

CO3: To implement motion control techniques to the robotic manipulators.

Course Content:

UNIT 1: **8 lecture hours**

Robot mechanics, Description of position and orientation of Manipulator, Transformation matrix, Compound Rotations, DH parameters, Frame arrangement and DH Representation, Forward and Inverse kinematics, Differential kinematics, Velocity propagation model for serial manipulators.

UNIT 2: **8 lecture hours**

Jacobian matrix for manipulator, Euler's angles, Manipulator Statics, Workspace singularities, Manipulator dynamics, Lagrange-Euler method for manipulator Dynamics, Newton-Euler method for Manipulator Dynamics, Manipulator motion in state-space.

UNIT 3: **6 lecture hours**

Trajectory generation using smooth functions, Trajectory generation schemes for serial manipulators, Robot motion control, Kinematic control.

UNIT 4: **6 lecture hours**

Dynamic control, Cascade control, DH description of Mobile robot, Kinematic and dynamic models of a mobile robot.

Laboratory:

This course will cover robot dynamics, trajectory generation, motion planning, and nonlinear control, and develop real-time planning and control software UNITs for robotic systems. This course will give you the basic theoretical tools and enable you to design control algorithms. Using MATLAB, you will apply what you have learned through a series of projects involving real-world robotic systems.

Text Books:

1. *Craig, John J. Introduction to robotics. Pearson Educacion, 2006. ISBN 0133489795.*
2. *Corke, Peter. Robotics and control: fundamental algorithms in MATLAB®. Vol. 141. springer Nature, 2021. ISBN 3030791785.*

Reference Books:

1. Mittal, R. K., and I. J. Nagrath. *Robotics and control.* Tata McGraw-Hill, 2003. ISBN 9780070482937.
2. Kurdila, Andrew J., and Pinhas Ben-Tzvi. "Dynamics and control of robotic systems." (2019). ISBN 9781119524830.

RAMA UNIVERSITY UTTAR PRADESH,
KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Specialization Electives: Artificial Intelligence

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS201	Advanced Computer Vision and Video Analytics	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate the key features of Computer Vision to analyze and interpret the visible world around us.
CO2: To build the applications of Deep Learning in Computer vision and video processing.
CO3: Implement the state-of-the-art computer vision and video analytics concepts to different applications.

Course Contents:

UNIT 1: **14 lecture hours**
Introduction to Computer Vision, The Four Rs of Computer Vision, Challenges in Computer Vision, Low-level vs High-level processing, Two View Geometry, Binocular Stereopsis: Camera and Epipolar Geometry, Planar Scenes and Homography, Depth estimation and multi-camera views, Robust Correspondence Estimation, 3-D reconstruction, Auto-calibration, DLT and RANSAC, Structure from Motion, Hough Transform, Fourier Transform, Interest Point Detection, Edge Detection, Local Binary Pattern, Convolution and Filtering, Gaussian derivative filters, Gabor Filters, DWT, Pyramids, Visual Matching: Bag-of-words, Pyramid Matching, Part based recognition models, Recognition: Detectors and Descriptors, Optical Flow & Tracking.

UNIT 2: **08 lecture hours**
Shape from Texture, Color, motion and edges, Face Detection, Feature Tracking, Motion Layers, SIFT & Single Object Recognition, Dense Neural Networks, Backpropagation, Convolutional Neural Networks (CNNs), AlexNet, VGG16, Image Quality Enhancement, Image Restoration, Super resolution, Residual Learning, Visual Saliency detection.

UNIT 3: **12 lecture hours**
Evolution of CNN Architectures: AlexNet, MobileNet, InceptionNets, ResNets, DenseNets, 3D CNN for images and videos, Unsupervised image segmentation, Watershed, Level set, Active Contour, GraphCut, Supervised image segmentation, Agglomerative clustering, Segmentation as pixel classification, UNets, FCN, Deep Generative Models, GANs, VAEs, PixelRNNs, naDE, Normalizing Flows, Zero-shot, One-shot, Few-shot Learning, Self-supervised Learning, Reinforcement Learning in Vision, Video Analytics, Spatial Domain Processing, Frequency Domain Processing, Background Modelling, Crowd Analysis, Video Surveillance, Traffic Monitoring, Intelligent Transport System.

UNIT 4: **08 lecture hours**
Optical Character Recognition, Online Character Recognition, Visual Anomaly Detection, Anomalous action recognition, Post Estimation, Action Recognition, Graph CNN, Shape Recognition, Shape Retrieval, Content based Image retrieval, Visual Instance Recognition, Emotion Recognition from videos, Video Generation.

Laboratory:

In the lab work, the students will Implement the state-of-the-art computer vision and video analytics concepts to different applications.

Text Books:

1. *Rajalingappaa Shanmugamani, Deep Learning for Computer Vision (1st ed.), Packt Publishing, 2018. ISBN 9781788295628.*
2. *Nedumaan J., Prof Thomas Binford, J. Lepika, J. Tisa, J. Ruby and P. S. Jagadeesh Kumar, Modern Deep Learning and advanced Computer Vision (1st ed.), Intel, 2019. ISBN 9781708798641.*

Reference Books :

1. Kar Krishnendu, *Mastering Computer Vision with Tensor Flow* (1st ed.), Packt, 2020. ISBN 9781838826939.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS202	Cognitive Modelling	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate the thought, learning, and mental organization.
CO2: To examine the extraction of brain signals into digital form and develop critical skills to evaluate and assess problems including psychology, philosophy, neuroscience, and computer modelling.
CO3: To implement the models that reflects human cognition and apply to different real-life scenarios.

Course Contents:

UNIT 1: **08 lecture hours**
Why Cognitive Science, Structure and processes of human cognition, Computational simulation or modelling, Theory and Research in Human Cognition, Object Perception, Object Recognition, Attentional Processes, Concept formation, Visual perception, Acquisition and processing of natural language, Human reasoning and problem-solving.

UNIT 2: **12 lecture hours**
Memory Introduction, Long Term Memory encoding, Retrieval from Long Term Memory, Memory of general knowledge, Semantic memory basics, Models of semantic memory, Human language skills, Midlevel Vision and Attention, Motion, disparity, depth, and orientation representation, Convolution, Mechanisms underlying attention, Attention at the cognitive/algorithm level.

UNIT 3: **10 lecture hours**
Brain Signals and Feature extraction, Types of Brain signals, case study, Feature extraction methods and their analysis, Models of Understanding Cognition or Mind: Neuroscientific Model, Psychological Model, Representational Model, Computational Model, Isomorphic Model, Multiple realizable Model, Multiple Draft Model, Sub personal Model.

UNIT 4: **12 lecture hours**
Thought process and Problem Solving, Applications of cognitive computing in the field of psychology, Applications of cognitive computing in linguistics, Decision Making models, Commercial Applications of Cognitive science/computing, Advanced Topics in Cognitive computing, Applications of cognitive computing in philosophy, Applications of cognitive computing in computer modelling, Machine Learning models for cognitive computing, Neural Networks for cognitive computing.

Text Books:

1. *Bermúdez José Luis, Cognitive Science: An Introduction to the Science of the Mind (3 ed.), Cambridge University Press, 2020. ISBN 978-1108440349.*

Reference Books :

1. High Rob and Tanmay Bakshi, *Cognitive Computing with IBM Watson: Build Smart Applications Using Artificial Intelligence as a Service* (1 ed.), Packt Publishing, 2019. ISBN 1788478290.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS203	Probability and Random Processes	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To explain the probability and random processes.

CO2: To formulate the problems and tackle with probability and random processes.

CO3: To implement the applications of probabilities for a real-world scenario.

Course Contents:

UNIT 1: **12 lecture hours**

Events, sample spaces, and probability, Limitation of classical and relative-frequency-based definitions, Independent events, Conditional probability, Sets and fields, Sample space and events, Axiomatic definition of probability, Joint probability, Conditional probability, Independence probability, Total probability, Stationarity: strict-sense stationary (SSS), wide-sense stationary (WSS) processes, Ergodicity and its importance, Bayes theorem, Combinatorics: Probability on finite sample spaces.

UNIT 2: **10 lecture hours**

Random variables, Discrete and continuous random variables, Probability mass functions, Moment generating functions – Binomial, Poisson, Geometric, Uniform distribution, Exponential, and Gamma distributions, Normal distributions: definitions, applications, Joint distributions – Marginal and conditional distributions, Covariance: definition, type, applications, Correlation regression, Linear regression, Transformation of random variables, Classification – Stationary process.

UNIT 3: **08 lecture hours**

Markov process, Poisson process, Random telegraph process, Bernoulli and Binomial random variables, Geometric random variables, Negative Binomial random variables, Random process realizations, Random process sample paths, Discrete time processes, Continuous time processes, Probabilistic structure of a random process.

UNIT 4: **12 lecture hours**

Mean functions, Autocorrelation functions, Autocovariance functions, Poisson random variables, Hypergeometric random variables, Discrete uniform random variables and counting, Independent continuous random variables, Normal distribution and CLT, Approximate models of continuous uniform distribution, Probability in Spam filtering, Random processes in gambling app design, Probability and random processes in market prediction and risk prediction.

Text Books:

1. *Peebles. P. Z, Probability, Random Variables and Random Signal Principles (4 ed.), Tata Mc Graw Hill, 2017. ISBN 978-0070474284.*

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS204	AI in Healthcare	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate the factors involved in decision support that can improve business performance across the provider/payer ecosystem.

CO2: To build methods and techniques in order to appropriately apply to pain points using case studies.

CO3: To build methods and techniques in order to appropriately apply to pain points using case studies.

Course Contents:

UNIT 1: **08 lecture hours**

History of AI in Medicine, AI for Decision Support, Capabilities and limitations of AI in Healthcare, Automated healthcare system: challenges and opportUNITies, Biostatistics, Research ethics in AI, Common healthcare data types, Medical data: quality vs quantity, Clinical Data, Clinical decision support systems, Electronic Health Records (EHR).

UNIT 2: **08 lecture hours**

Time series and non-time series data, Data Sourcing, Data Enrichment, Handling missing values, Advantages and challenges in observational data, Geographic and demographic variation in medical Data, Classification, regression, clustering for healthcare, Evaluation measures for healthcare applications, Bias and Error in medical data, Analysis of data from IOT body sensors, Automated diagnosis processes, Treatment protocol development.

UNIT 3: **12 lecture hours**

Time series and non-time series data, Data Sourcing, Data Enrichment, Handling missing values, Advantages and challenges in observational data, Geographic and demographic variation in medical Data, Classification, regression, clustering for healthcare, Evaluation measures for healthcare applications, Bias and Error in medical data, Analysis of data from IOT body sensors, Automated diagnosis processes, Treatment protocol development.

UNIT 4: **14 lecture hours**

Clinical text, Medical Word Corpus, Text representation, BERT for medical data, PubMed BERT, Question answering systems, finding similar patients through clustering, Medicine or treatment recommender systems, Q&A systems for Telemedicine, Personalized medicine recommendation system, Drug development analysis, Drug discovery, Modeling drug-drug interactions, Pandemic spread prediction, Infection pattern identification, Computer Vision systems for physiotherapy, Pose estimation, Gait Analysis.

Text Books:

1. Bohr A. and Kaveh Memarzadeh, *Artificial Intelligence in Healthcare* (1 ed.), Elsevier Science, 2020. ISBN 978-0128184387.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS205	Image and Video Processing	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To explain and Analyze images using Histograms and spatial filters. Apply Hough transforms and be familiar with image representation using textures.
CO2: To compute motion using optical flow and understand methods for image description and morphological operations.
CO3: To implement different low-level and high-level image and video processing techniques to wide variety of applications.

Course Contents:

UNIT 1: **12 lecture hours**
Applications of Digital Image Processing, Elements of Digital image processing systems, Sampling and quantization, Neighbors of a pixel, adjacency, connectivity, Regions and Boundaries, Distance measures, Gray scale to Binary image using thresholding, Image Enhancement in the Spatial domain, Gray level transforms, Histogram Processing, Histogram Equalization, Enhancement using Spatial filters, Concept of convolution, Smoothing, Mean, median and Gaussian filters, Edge detection using Prewitt, Sobel, Laplace Filters, Laplace of Gaussian Filter.

UNIT 2: **10 lecture hours**
Canny Edge Detector, Harris Corner Detector, Color models, RGB, HSV, YCbCr models, Pseudocolor Image Processing, Color Transforms, Color to grayscale conversion, Handling Binary Images, Line detection using Hough transform, Polar form, Circle Detection, Morphological Operations, Dilation, Erosion, Opening, Closing, Boundary detection, Hole filling, connected components, Hit and Miss transform, Shape representation using moments, Texture analysis, Texture from histogram, Texture from GLCM matrices.

UNIT 3: **12 lecture hours**
Motion Detection, Concept of Optical Flow, Optical flow equation, Lucas Kanade method, Image Enhancement in the Frequency domain, 1-D and 2-D Fourier Transform and their Inverse, Low pass and Hi pass Filtering, Ideal and Butterworth and Gaussian Filters, Homomorphic Filtering, Image Compression Fundamentals, Lossless Compression Models, Run length Encoding, Huffman Coding, Lossy Compression, Discrete Cosine Transform, Quantization, Zigzag coding, Color image compression, Text recognition, Feature detection, Integral Image Formation.

UNIT 4: **08 lecture hours**
Face Detection – Viola Jones method, Face Recognition, Principal Component Analysis (PCA),Concept of Eigenface, Feature detection for Machine learning applications, SIFT and HOG parameters, Video Processing, Video formation, Video sampling, Motion estimation, Motioncompensated (MC) filtering, Frame-rate conversion, Video Coding, Video Compression, Frame

based compression (MPEG), Salient object detection, Human action recognition from videos, Depth cameras– Kinect camera data capture, RGBD data.

Text Books:

1. *Szeliski Richard, Computer Vision: Algorithms and Applications (2 ed.), Springer, 2022. ISBN 978-3030343712.*
2. *Jain K., Fundamentals of Digital Image Processing (1st ed.), Pearson Education India, 2015. ISBN 978-9332551916.*

Reference Books:

1. Bovik, A. C., *Handbook of image and video processing* (1 ed.), Academic press, 2010. ISBN 9780121197902.
2. Kim, B. G., *Digital Signal, Image and Video Processing for Emerging Multimedia Technology. Electronics* (1 ed.), Mdpi AG, 2021. ISBN 978-3039438570.
3. Vyas, A., Yu, S. and Paik, J., *Fundamentals of digital image processing. In Multiscale Transforms with Application to Image Processing* (1 ed.), Springer, 2018. ISBN 978-9811356131.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS206	Information Retrieval and Search Engine	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To explain the comprehend types of text analysis, Information retrieval, IR system architecture, query processing models and probabilistic models.
CO2: To build information retrieval systems by performing indexing, compression, information categorization sentiment analysis, network management, search engine optimization, records compliance and risk management.
CO3: Implement different information retrieval approaches for applications in text domain.

Course Contents:

UNIT 1: **14 lecture hours**

Text analysis and types, Information retrieval, Text processing, Indexes and query matching, Semi structured text data, Tokenization, Stemming, Lemmatization, Language modelling, Examples of open source IR Systems, Query processing models, Probabilistic models, Binary independence model, Robertson/Spark Jones weighting formula, Two-Poisson model, Relevance feedback, Term selection, Pseudo relevance feedback, Language models, Unigram, Bigram language models, Generating queries from documents, Language models and smoothing, Ranking with language models, Retrieval evaluation measures Normalized Discounted Cumulative Gain (NDCG), Kullback-Leibler divergence, Divergence from randomness, Passage retrieval and ranking, Management of Information Retrieval Systems, Knowledge management, Information management, Digital asset management, Network management.

UNIT 2: **14 lecture hours**

Search engine optimization, Records compliance and risk management, Version control, Data and data quality, Information system failure, Web retrieval and mining, Semantic web, XML information retrieval, Recommender systems and expert locators, Knowledge management systems, Decision support systems, Geographic information system (GIS), Indexing, Inverted indices, Index components and Index life cycle, Interleaving Dictionary and Postings lists, Index construction, Query processing for ranked retrieval, Compression, General-purpose data compression, Symbol wise data compression, Compressing posting lists, Compressing the dictionary.

UNIT 3: **14 lecture hours**

Information categorization and filtering, Classification, Probabilistic classifiers, Linear classifiers, Similarity-based classifiers, Multi category ranking and classification, Learning to rank, Text Clustering, Partitioning methods, Clustering versus classification, Reduced dimensionality/spectral methods, Lexicons, Corpora, Sentiment Analysis, Document-level, Sentence-level and Aspect-based sentiment analysis, Web crawling, Near duplicate pages, Distributed word representations, Link Analysis, PageRank algorithm, Search engine bias, Personalized searching, Question Answering, Cross-lingual retrieval, Adversarial Information Retrieval.

Text Books:

1. *Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, Introduction to Information Retrieval (1 ed.), Cambridge University Press, 2019. ISBN 9781107666392.*
2. *Mitra Bhaskar and Nick Craswell, An Introduction to Neural Information Retrieval (1 ed.), Boston-Delft, 2019. ISBN 9781680835327.*

Reference Books :

1. Sarfraz Muhammad, *Critical Approaches to Information Retrieval Research* (1ed.), IGI Global, 2019. ISBN 9781799810232.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS207	Natural Language Processing	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate natural language processing and importance of word representation.
CO2: To build deep learning model for solving natural language problems such as language modelling, machine translation, POS tagging, Seq2Seq generation.
CO3: To implement state-of-the-art Machine Learning and Deep Learning solutions to NLP problems in Global & Indian context.

Course Contents:

UNIT 1: **12 lecture hours**

Natural Language Processing: Need, applications, industry demand, Challenges in NLP: Ambiguity in language, Contextual words and phrases and homonyms, Coreference, Domain-specific language, Low-resource languages, Segmentation, Stemming, Lemmatization, Spelling correction, Synsets, Hypernyms, Tokenization, N-grams, Stops Words, WordNet, WordNet Similarity, Language Corpus, N-gram Language Models, Hidden Markov Models.

UNIT 2: **08 lecture hours**

NLTK (natural Language Toolkit for Indic Languages), Text normalization, script normalization, Parallel Corpus, Handling Code-mix text, Cross Lingual Information Retrieval, Word representation, Sentence representation, Word embedding, Vector space model, Term Frequency, TF-IDF Representation, Distributional representation, Word2vec: CBOW(20), Word embedding for regional language, Word2Vec, GloVe, Document to Vector.

UNIT 3: **10 lecture hours**

Neural Networks for text, Recurrent Neural Networks, Vanishing Gradients, exploding gradient, LSTM (Long sort term memory), GRU (Gated recurrent UNIT), Seq2Seq Modelling, Bidirectional Model, Contextual Representations, Transformers, BERT, Multilingual Embedding, Transfer Learning in Word Embeddings, MUSE, POS tagging, named Entity Recognition, Sentiment Analysis, Text Clustering.

UNIT 4: **12 lecture hours**

Topic Modeling, Latent Semantic Analysis, Statistical Machine Translation, Neural Machine Translation, Self-Attention for Generative Models, natural Language Generation, Attention, Question Answering Bot, 1D-CNN for NLP, Sub-word Models, Openal's GPT, Google's ALBERT ULMFiT, Facebook's RoBERTa, Text Summarization, Extractive, Abstractive Text summarization, Transformer models for Text Summarization.

Text Books :

1. *Rao Delip and Brian McMahan, natural Language Processing with PyTorch: Build Intelligent Language Applications Using Deep Learning (1 ed.), O'Reilly Media, 2019. ISBN 9781491978238.*

Reference Books :

1. Eisenstein Jacob, *Introduction to natural Language Processing* (1 ed.), The MIT Press; Illustrated edition, 2019. ISBN 9780262042843.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS208	Social Network Analysis	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To understand human behavior in social networks and related communities.
CO2: To build and apply networking models for understanding social interactions.
CO3: To implement network media graph virtualization and network relationships.

Course Contents:

UNIT 1: **12 lecture hours**

Social network analysis purposes, Phenomenology of social media, Social network monitoring tools , Entity resolution, Types of social networks, Networks Representation, Adjacency Matrix, Weighted and Directed Networks, Hypergraphs, Bipartite Networks, Graph Laplacian, Random Walks, One mode and two mode networks, Heterogeneous Information Networks, Closeness centrality, Betweenness centrality, Eigenvector centrality, Clustering coefficient, Density of graphs, Isomorphic graphs, Reachability, Cliques, Graph coloring problem, Valued graphs, Multi graphs.

UNIT 2: **10 lecture hours**

Large Scale Structure of Networks, Small World Effect, Degree Distributions, Power Law, Scale Free Networks, Assortative Mixing, Time series analysis in graph, Temporal graph algorithms, Parallel dynamic graph algorithm, Matching theory, Bipartite matching, Konig's theorem, Hall's Matching Theorem, Network flow, Max flow min cut theorem, Menger's theorem, Ford Fulkerson method.

UNIT 3: **08 lecture hours**

Ties, Structural holes, Structural balance, Equivalence, Motifs, Random Graphs, Giant Component, Small Components, Configuration Model, Excess Degree Distribution, Vertex Copying network models, Erdős-Rényi model, Barabási–Albert model, Exponential Random Graphs, Percolation

UNIT 4: **12 lecture hours**

CommUNITies in network, CommUNITy detection from network, Louvain Method, overlapping commUNITies, Non-overlapping commUNITies, Information diffusion in social networks, Cascading Behavior in Networks, Link Prediction, Preferential Attachment, Geospatial social networks, Crowdsourcing, Rumours and Deception in social network, Fake News, Spamming, Identify theft.

Text Books:

1. *Blokdyk Gerardus, Social Network Analysis A Complete Guide (3 ed.), 5starcooks, 2020. ISBN 978-1867330097.*
2. *Beineke L.W., Martin Charles Golumbic and Robin J. Wilson, Topics in Algorithmic Graph Theory (1 ed.), Cambridge University Press, 2021. ISBN 9781108492607.*

Reference Books:

1. Dey Nilanjan, *Social Network Analytics: Computational Research Methods and Techniques* (1 ed.), Academic Press, 2018. ISBN 978-0128154588.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS209	Reinforcement Learning	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Understand key features of Reinforcement Learning (RL).
CO2: Decide, formulate, design, and implement given application as RL problem.
CO3: Implement common RL algorithms and evaluate them using relevant metrics.

Course Contents:

UNIT 1: **10 lecture hours**
Introduction to RL: Course logistics and overview, Introduction to Reinforcement Learning (RL), Origin and history of RL research, RL and its connections with other ML branches. Linear algebra overview, Probability overview, Sequential Decision Making, Modelling the world, Components of a reinforcement learning agent, Taxonomy of reinforcement learning agents. Introduction to Instance based learning.

UNIT 2: **08 lecture hours**
Markov Decision Processes and Bandit Algorithms, Policy Gradient Methods & Introduction to Full RL, Reinforcement Learning Problems, MDP Formulation, Bellman Equations & Optimality Proofs, Markov Processes, Markov Reward Processes, Markov Decision Processes, Bellman Equation, Bandit Algorithms (UCB, PAC, Median Elimination, Policy Gradient), Contextual Bandits.

UNIT 3: **12 lecture hours**
Dynamic Programming & Temporal Difference Methods, DQN, Fitted Q & Policy Gradient Approaches, Introduction to Dynamic Programming, Policy Evaluation (Prediction), Policy Improvement, Policy Iteration, Hierarchical Reinforcement Learning, Value Iteration, Generalized Policy Iteration, Hierarchical RL: MAXQ, Asynchronous Dynamic Programming, Efficiency of Dynamic Programming, Temporal Difference Prediction, Why TD Prediction Methods, On-Policy and Off-Policy Learning, Q-learning, Reinforcement Learning in Continuous Spaces, SARSA.

UNIT 4: **14 lecture hours**
Dynamic Programming & Temporal Difference Methods, DQN, Fitted Q & Policy Gradient Approaches, Introduction to Dynamic Programming, Policy Evaluation (Prediction), Policy Improvement, Policy Iteration, Hierarchical Reinforcement Learning, Value Iteration, Generalized Policy Iteration, Hierarchical RL: MAXQ, Asynchronous Dynamic Programming, Efficiency of Dynamic Programming, Temporal Difference Prediction, Why TD Prediction Methods, On-Policy and Off-Policy Learning, Q-learning, Reinforcement Learning in Continuous Spaces, SARSA Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control, Monte Carlo Control without Exploring Starts, Incremental Implementation, Policy optimization methods (Trust Region Policy Optimization (TRPO) and Proximal Policy, Optimization (PPO).

Laboratory:
Implement a RL simulator environment in Python to familiarize with basics. Implement Markov Chain model with random state, action, rewards and perform inference with random input sequence.

Implement a simple 2D Atari game playing using CNN based Q learning model. Implement self-driving car system using DQN with input from simulators. Implement a news recommendation system using reinforcement learning techniques. Implement dynamic programming based RL system for board games. Implement a stock prediction and trading system using RL concepts. Implement a multi-document text summarization using Monte Carlo RL. Implement RL based Chatbot for improved customer engagement. Implement a multi-agent RL system for drone navigation using simulator libraries.

Text Books:

1. *Sutton R.S. and Andrew G. Barto, Reinforcement Learning: An Introduction (2 ed.), MIT Press, 2017. ISBN 978-0262039246.*
2. *Murphy K.P., Machine Learning: A Probabilistic Perspective (1 ed.), MIT Press, 2012. ISBN 978-0262018029.*

Reference Books :

1. Bertsikas Dimitri and John G. Tsitsiklis, Neuro Dynamic Programming, Athena Scientific (1 ed.), Athena Scientific, 1996. ISBN 978-1886529106. .
2. Sewak Mohit, Deep Reinforcement learning: Frontiers of Artificial Intelligence (1 ed.), Springer, 2019. ISBN 978-9811382840..
3. Masashi Sugiyama, *Statistical reinforcement learning: modern machine learning approaches* (1 ed.), Chapman and Hall/CRC, 2015. ISBN 978-1439856895.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS210	Emerging Topics in Artificial Intelligence	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Develop an understanding of the current trends and challenges of emerging Artificial Intelligence (AI) technologies.

CO2: Identify and analyse potential applications of AI in the context of real-world problems.

Course Contents:

UNIT 1: **42 lecture hours**

The Emerging Topics in Artificial Intelligence course will provide an overview of the current state of Artificial Intelligence (AI) research. Students will learn about the major topics in AI such as machine learning, natural language processing, computer vision, robotics, and reinforcement learning. Additionally, students will be exposed to the latest applications of AI in various domains such as healthcare, finance, and autonomous vehicles. They will learn how to apply AI algorithms and explore the ethical implications of AI. Finally, students will get an introduction to the potential future of AI and the implications of these technologies on society.

Laboratory:

Students will gain practical experience by using tools and technologies related to Artificial Intelligence.

RAMA UNIVERSITY UTTAR PRADESH,
KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Specialization Electives: Data Science

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS211	Digital Marketing and Trend Analysis	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate online applications based on recent digital marketing trends.
CO2: To examine digital marketing and its applications.
CO3: To make use of state-of-the-art tools for digital marketing and trend analysis.

Course Contents:

UNIT 1: **12 lecture hours**
Digital Marketing, CRM, Affiliate Marketing, P-O-E-M Framework, Online vs offline retail, Customer profile analysis, Factors influencing consumer behavior, Traffic source analysis, Multi- channel analysis, On-site merchandising analysis, Digital Advertising Market, Growth of e- commerce, Social media monitoring vs listening, Competitor and Website Analysis, Structure of online conversations, Methods of gathering data, Unlocking actionable insights from e-commerce, Adwords, Link Tagging, Exit rate and bound rate, Online advertising optimization, Measuring Performance and Quality Control, Crisis management.

UNIT 2: **10 lecture hours**
Online content, Content Creation, Types of Content, Content optimization, Content Management & Distribution, Recommendation system for e-commerce, User-User and User Item, Study of popular recommendation platforms, Market basket analysis, Predicting product adoption.

UNIT 3: **12 lecture hours**
Conversation modeling, Campaign optimization, Clickstream Analytics, Traffic Analytics, Customer segmentation, Search Engine Optimization techniques, Expertise Authority and Trustworthiness, Featured Snippets, Site architecture optimization, Long-Tail Keyword Phrases, Keyword Planner, Google rankings, Link Building, Steps to optimize the website.

UNIT 4: **08 lecture hours**
Mobile Advertising, Mobile Marketing tool Kit, Mobile Marketing Features, Brand Health Management, Surrogate advertising, Fake news propagation models, Fake news identification, Social Media Monitoring, Digital data treasure, Digital rights.

Text Books:

1. *Gary P Schneider, Electronic commerce (13th ed.), Cengage Learning, Inc, 2019. ISBN 9781285425436.*
2. *Kingsnorth Simon , Digital Marketing Strategy: An Integrated Approach to Online Marketing (4th ed.), Pearson, 2019. ISBN 0749484225.*

Reference Books :

1. Clarke Adam, *SEO 2020* (2nd ed.), Amazon Digital Services LLC - KDP Print, 2019. ISBN 9781712354889.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS212	Structural Equation Modelling	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To explain the statistical and numerical models used in SEM Framework.

CO2: To build factor analysis to find multiple hidden variables.

CO3: To implement of parameter estimation and regression analysis of practical frameworks.

Course Contents:

UNIT 1: **12 lecture hours**

Structural Equation Modelling, Representation of Structural Equation Models using Path Diagrams, Multiple Regression, Estimation Parameters, Least Squares estimation, Latent Variable Estimation, Estimation with Non-normal Distributions, Computing Power, Equivalent Models, Causal Foundations of SEM, Representing Interventions, Causal effects, Model Specification, Identification and Estimation, Power Analysis, Categorical Data in SEM Framework.

UNIT 2: **08 lecture hours**

Model Fitting, Model Selection, Path Modelling, Covariance Structure Analysis, Parameter Estimation, Maximum Likelihood, EM Algorithm, Bootstrapping Standard Errors, Bayesian bootstrap, Smooth bootstrap.

UNIT 3: **12 lecture hours**

Factor Analysis, Factor quantification and selection, Exploratory factor analysis, Factor selection and rotation, Velicer's Minimum Average Partial test, Convergence of Tests, Confirmatory Factor Analysis, Investigating Measurement Invariance, Indirect Effects in SEM, Bootstrapping Methods, Monte Carlo Method, Likelihood Ratio Test, Single-Group and Multi-Group Approaches.

UNIT 4: **10 lecture hours**

Latent Interaction Modelling, Quasi-maximum-likelihood (QML), Multilevel Modelling of Networks, Linear and non-linear Multilevel Networks, Growth Mixture Modelling, Multiple-group Growth Curve Modelling, Latent Curve Modelling of Longitudinal Growth Data, Adding Covariates and Multiple Causes Model, Estimating Group Effects, Moderation, Mediation Effect, Indirect effect.

Text Books:

1. *Thakkar Jitesh J., Structural Equation Modelling: Application for Research and Practice (1st ed.), Springer, 2020. ISBN 978-9811537929.*

Reference Books :

1. Civelek Mustafa Emre, *Essentials of Structural equation modelling* (1st ed.), Zea Books, 2019. ISBN 978-1-60962-129-2.

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS213	Time Series Analysis	L	T	P	C

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To explain the working of different components of a time series.

CO2: To build autoregressive models for time series forecasting.

CO3: To implement multiple time series methods on real-world datasets.

Course Contents:

UNIT 1: **12 lecture hours**

Purpose of Time Series Analysis, Descriptive techniques, Times series plots, Line chart, visualizing multidimensional Time series, Visualizing multiple time series, Histograms, Seasonal effects and trend identification, Transformations, Sample autocorrelation, Correlogram, Time series filtering, Probability models, Stochastic processes, Bernoulli Process, Weiner process, Brownian Motion, Ornstein-Uhlenbeck Process, Stationarity, Second-order stationarity, Autocorrelation.

UNIT 2: **12 lecture hours**

White noise model, Random walks, moving average, Invertibility, ARIMA Models, Autoregressive processes, Fitting an AR process, Yule–Walker equations, General linear process, Wold decomposition theorem, Time series Forecasting, Exponential smoothing, Holt-Winters, Box- Jenkins forecasting, Optimality models for exponential smoothing, Model selection for time series forecasting.

UNIT 3: **08 lecture hours**

Spectral analysis, Sinusoidal model, Wiener-Khintchine theory, Cramer representation, Periodogram analysis, Statistical properties of periodogram, Consistent estimators of spectral density, Bivariate processes, Cross-covariance, Cross-correlation, ARCH, GARCH.

UNIT 4: **10 lecture hours**

Gaussian Process, Gaussian Regression, Vector autoregression models VAR, Structural Form, Reduced Form, Parameter Estimation, Kernel Methods for forecasting, Adaptive filtering mechanism for forecasting, Statistical Testing for stationarity, Augmented Dickey-Fuller, Kwiatkowski–Phillips–Schmidt–Shin Test, Goodness of estimation.

Text Books:

1. *Nielsen Aileen, Practical Time Series Analysis: Prediction with Statistics and Machine Learning (1st ed.), O'Reilly, 2019. ISBN 1492041653.*
2. *Mills Terence C., Applied Time Series Analysis: A Practical Guide to Modelling and Forecasting (1st ed.), Academic Press, 2019. ISBN 978-0-12-813117-6.*

Reference Books :

1. Nielsen Aileen, *Practical Time Series Analysis* (1st ed.), O'Reilly, 2019. ISBN 9781492041629.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS214	Data Visualization and Dashboards	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To explain best practices in data visualization to develop charts, maps, tables, and other visual representations of data.
CO2: To build an interactive dashboard for a cohesive and seamless visualization.
CO3: To implement different visualization approaches on real-world datasets.

Course Contents:

UNIT 1: **12 lecture hours**
Gathering data and Business process modelling, Business reference model, Business process integration, Workflow modelling, Business process Management, Visualizing Workflow, Layered graph drawing, Layout Algorithm, Information visualization, Graph Drawing Theory, Layout Methods, Forced Layout, Spectral Layout, Tree Layout, Exploratory Visualization, Visual data exploration, Visual thinking.

UNIT 2: **12 lecture hours**
Visual Analytics, Visualization from Heterogenous data sources, Reasoning and data representation, Optimal visualization types, Binning, Dashboard development, Design principles, Interactivity, Connected drill-down dashboards, Drill Down and Drill Up Charts, Bidirectional Relationship, Working with stakeholders, Stakeholder categories, Creating analytical products, Receiving feedback, Dashboard retune, Design iterations.

UNIT 3: **08 lecture hours**
Performance management, Balanced scorecard, Showing Rank and Magnitude, Bump Chart, Measuring Claims across Multiple Dimensions, KPI wheel, Quantitative KPI, Qualitative KPI, Lagging KPI, Leading KPI, KPI Reporting.

UNIT 4: **10 lecture hours**
Actual versus Potential Utilization, Utilization rollup dashboard, Personalized Dashboards, Demographics Dashboard, Visualizing Trends Across Dimensions, Comparing growth rates, Assessing the quality of dashboards, Measuring success, Dashboard Administration, Designing Colour-Blind-Friendly Visualizations.

Text Books:

1. *Wexler Steve, Jeffrey Shaffer and Andy Cotgreave, The Big Book of Dashboards: Visualizing Your Data Using Real-World Business Scenarios (1st ed.), John Wiley & Sons, 2017. ISBN 978-1119282716.*

Reference Books :

1. Kusleika Dick, *Data Visualization with Excel Dashboards and Reports* (1st ed.), ohn Wiley & Sons, 2021. ISBN 1119698723.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS215	Security and Privacy for Big Data Analytics	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate security threats in big data analytics.
CO2: To examine the system vulnerabilities, exploitation.
CO3: To implement defence mechanisms on big data analytics.

Course Contents:

UNIT 1: **14 lecture hours**
Introduction and Basic Concepts, privacy by design, security roadmap, Map Reduce Architecture, Detailed Design of Architecture, Hadoop, Spark, Hive etc. Generic Data Security, Data Theft, Data Manipulations, Privilege Escalations, Big Data Storage based Security Issues, Hardware Failure Impacts, Known Trivial Countermeasures, Failure of Trivial Methods on Big Data.

UNIT 2: **14 lecture hours**
Case Study of Stolen Data in Big Data Environment, Types of Threats, Distinguished Security Goals for Big Data, Implementing Security on Big Data: Methods and Aim of each Method, Administrative Measures of Big Data, Preventive Measures of Big Data Security using Encryption, Preventive Measures of Big Data Security using Access Control, Detective Measures of Security in Big Data, Auditing, Log Analysis, Data and Network Monitoring Methods and Tools, Best Practice for Securing Big Data, Security Cost of Big Data, Data Anonymization, Data Pseudo Anonymization.

UNIT 3: **14 lecture hours**
Differential Privacy in Big Data, Methods for Differential Privacy and Impact of each Method, Homomorphic Encryption, Heteromorphic Encryption, Complexity Analysis of Encryption Techniques, Complexity Analysis of Privacy-based Methods. Malware and their Impact on Big Data, Secure Multiparty Communication in Distributed Environment, Data Protection Laws for Big Data, General Data Protection Regulation, Important changes resulting from the GDPR, Personal Data, Personal data and Big Data applications.

Text Books:

1. *Joshi R., Security, Privacy, and Forensics Issues in Big Data Network Security Essentials (1st ed.), IGI Global, 2019. ISBN 978-1522597421.*

Reference Books :

1. Gupta Brij B. and Ramesh C. Joshi, *Security, Privacy and Forensics Issues in Big Data* (1st ed.), GI Global, 2019. ISBN 9781522597441.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS216	Big Data Analytics and Business Intelligence	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs):

On completion of this course, the students will be able to:

CO1: To articulate key technologies in data science and business analytics.

CO2: To build Big Data framework: Hadoop (HDFS and MapReduce), Hadoop Ecosystem & spark.

CO3: To make use of cutting-edge tools and technologies to analyze Big Data.

Course Contents:

UNIT 1: **14 lecture hours**

Big Data Analytics: Data and Relations, Business Intelligence, Business intelligence vs business analytics, Big Data Predictive Analysis, Why what and how BI?, OLTP VS OLAP, Project life cycle, Methodology, Impact Analysis, Testing and release management, Ethics in Business Intelligence, Big Data Technology Component, Real Time Analysis of Big Data, Big Data Architecture, Cost Conscious Design, Storage Conscious Design.

UNIT 2: **12 lecture hours**

Big Data Warehouse, Functional vs Procedural programming models, Data placement strategies, CAP Theorem, Streaming, Stream Data Types, Stream Computing, Filtering Stream, Estimating Moments, NoSQL, Aggregate Data Models, Document Data Model, Schema Less Databases.

UNIT 3: **06 lecture hours**

Hadoop Ecosystem, Hadoop Overview, HDFS, Map-Reduce, Pig Overview, Pig Grunt Shell, Hive, HBase, Architecture of Hive and HBase.

UNIT 4: **10 lecture hours**

HQL, Associations and Joins, Aggregate function, Polymorphic queries, Clauses, Subqueries, Spark, Core, Spark SQL, Spark RDD, Deployment and Integration, Spark GraphX and Graph Analytics, Research Topics in Big Data Analytics.

Text Books:

1. *Ghavami Peter , Big Data Analytics Methods (2nd ed.), De Gruyter, 2020. ISBN 9781547417951.*
2. *Acharya and Seema, Data Analytics using R (1st ed.), New York: McGraw-Hill Education, 2018. ISBN 9352605241.*

Reference Books :

1. Azevedo Ana and Manuel Filipe Santos, *Integration Challenges for Analytics, Business Intelligence, and Data Mining* (1st ed.), Engineering Science Reference, 2020. ISBN 9781799857832.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS217	Advanced Database Management System	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate the concepts of transaction processing, concurrency control techniques, database recovery techniques.
CO2: To build distributed and object-oriented databases and learn to apply concurrency control and recovery algorithms.
CO3: To implement distributed and Object-Oriented DBMS to speed up information processing and storage.

Course Contents:

UNIT 1: **12 lecture hours**
ER Model, Indexing Dependencies, Transaction processing, Transaction management, Scheduling in Databases, Serial Scheduler, Non-Serial Schedulers, Concurrency Control, Time stamp ordering Protocol, Multi version concurrency control, Validation concurrency control, Recovery Techniques in Databases, Undoing, Deferred Update, Immediate Update, Buffering and Caching in Databases, Design Elements, Cache SQL ResultSet, Cache selected fields and values, Caching serialized applications, Shadow Paging, Data Backup Architecture, Transaction logging, Paging Architecture in Databases, Full Backup, Differential Backup.

UNIT 2: **10 lecture hours**
Distributed DBMS, Architecture of a DDBMS, Distributed Design of Relational Database, Variant of the 2 Tier Model, Fragmentation and Replication, Update in DDBMS, Update Strategies, Eager update, Distributed Reliability, Phase commit protocol, Asynchronous Update, Distributed transaction management, Distributed concurrency control, Distributed deadlock management.

UNIT 3: **12 lecture hours**
Object-Oriented DBMS Architecture, Capturing Semantics, Message Passing, OODB persistence, Object relational database model, Object relational features, Object tables, Nested tables, Varying arrays, Support for large objects, Database Migration, Migration Architecture, Heterogeneous migration versus homogeneous migration, Migration consistency, Database Transformation, Differential Querying, Migration Consistency Verification, Order violation, Consistency violation, Local Transactions.

UNIT 4: **08 lecture hours**
Flex Cluster Architecture, Policy-Based Cluster, Grid Infrastructure, Kernel Requirements, Data Redaction, Database Auditing, Database Diagnostic Monitor, Global User Authentication, Label Security, Data Masking, Privilege Analysis, Virtual Private Databases.

Text Books:

1. *Connolly Thomas and Carolyn Begg, Database Systems (6th ed.), Pearson, 2019. ISBN 9789353438913.*

2. *Sadalage Pramod J and Martin Fowler, NoSQL Distilled (1st ed.), Pearson, 2012. ISBN 9780321826626.*

Reference Books :

1. Hoffer prescott and Mcfadden, *Modern Database Management* (8th ed.), Prentice Hall, 2008. ISBN 978-8131709481.
2. Bayross Ivan, *SQL and PL/SQL* (4th ed.), BPB Publications, 2010. ISBN 978-8176569644.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS218	Satellite Data Analysis	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Analyse the Fundamental mechanism of GIS and Process spatial and attribute data towards preparation of thematic maps.
CO2: Understand and Interpret the various land features over satellite images.
CO3: Generate and publish the spatial maps derived from satellite data to be used for societal applications.

Course Contents:

UNIT 1: **14 lecture hours**
GIS Definition, GIS applications, Geospatial data for GIS applications, digital representation of geospatial data. Concepts of mapping, Paper based maps vs digital maps, map scale, map projection, limitations, Cartography – History and Developments, advantages of digital maps. Electromagnetic spectrum, Pre-processing of Satellite Images- Georeferencing and Image enhancement, Ground Control Points collection Electromagnetic spectrum, Pre-processing of Satellite Images-Georeferencing and Image enhancement, Ground Control Points collection.

UNIT 2: **12 lecture hours**
Key Elements of Satellite Image Interpretation- Color, Texture, size, shape etc. Raster Based GIS-raster representation of data grid size and resolution, raster data structures, advantages/disadvantages of raster data models, data capture, raster to vector conversion VECTOR BASED GIS, Vector representation of data, advantages/disadvantages of vector data models, data bases Spatial and Non-spatial data, Data Collection, Data Formats, Data Conversion.

UNIT 3: **08 lecture hours**
Spatial Database Management – Database Structures, Files; Standard Data Formats, Information Systems, Modelling Real World Features Data Spatial Analysis and Modelling – Proximity Analysis, Overlay Analysis, Buffer Analysis Network Analysis-finding shortest path and Overview of methods of multicriteria analysis for education and health applications.

UNIT 4: **08 lecture hours**
Integration of Elevation data- DTM/DEM with satellite images Generating 3-dimensional view of the land features from satellite images Open source tools for publishing spatial maps-Geoserver.

Text Books:

1. *Chang, K. T., Introduction to geographic information systems (9 ed.), McGraw-Hill Higher Education, 2019. ISBN 978-1260136371.*
2. *Lillesand, T., Kiefer, R. W., and Chipman, J., Remote sensing and image interpretation (7 ed.), John Wiley & Sons, 2014. ISBN 978-1118343289.*

Reference Books :

1. Bernhardsen, T., *Geographic information systems: an introduction* (3 ed.), Wiley, 2010. ISBN 978-8126511389.
2. Chris Brunsdon and Lex Comber, *An Introduction to R for Spatial Analysis and Mapping (Spatial Analytics and GIS)* (2 ed.), SAGE Publications Ltd, 2019. ISBN 978-1526428509.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS219	Emerging Topics in Data Science	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1. Develop an understanding of the current trends, tools, and techniques applicable to data science in order to apply them to solve real-world business problems.

CO2. Explore and analyse large datasets using advanced analytics and machine learning techniques to gain insights and develop effective data-driven solutions.

Course Content:

UNIT 1: **42 lecture hours**

Data Science is a rapidly growing field with new and exciting topics emerging all the time. Some of the most interesting and emerging topics in Data Science include data visualization, machine learning, natural language processing, data mining, deep learning, big data analytics, and predictive analytics. Data visualization is the process of creating visual representations of data, such as graphs, charts, and maps, to make it easier to understand and interpret. Machine learning is the process of using algorithms to identify patterns and trends in data. Natural language processing makes it possible for machines to understand and interpret human language. Data mining is the process of extracting information from large datasets. Deep learning is a subset of machine learning that is used to create models for more accurate predictions and analysis. Big data analytics is the process of extracting, transforming, and loading large datasets for analysis and decision making. Predictive analytics is the process of using data to make predictions about future events. These topics and more are all part of the ever-growing field of Data Science.

Laboratory:

Students will gain practical experience by using tools and technologies related to Data Science

RAMA UNIVERSITY UTTAR PRADESH,
KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Specialization Electives: IoT and Robotics

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS220	IoT Analytics	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate visualization, processing, and storage of device data in a time-series data store.
CO2: To examine collect, process, and analyze data from IoT Cloud.
CO3: To make use of IoT devices that are integrated with IoT Analytics services.

Course Contents:

UNIT 1: **14 lecture hours**

Need of IoT analytics, IoT analytics challenges, Business value concerns, IoT Analytics for the Cloud, Building elastic analytics, PUBLIC CLOUD overview, PUBLIC CLOUD key concepts, PUBLIC CLOUD key core services, PUBLIC CLOUD key services for IoT analytics, Creating an PUBLIC CLOUD Cloud, Analytics Environment, Collecting Data from PUBLIC CLOUD Cloud, Data processing for analytics, Applying big data technology to storage: Hadoop, HBase, Amazon DynamoDB, Amazon S3, Apache Spark for data processing.

UNIT 2: **14 lecture hours**

Adding External and Internal datasets, IoT Dashboards, Sensor data visualizing, Feature engineering with IoT data, Dealing with missing values, centering, and scaling, Machine learning (ML) Model Representation, Evaluation, Optimization, Time series data handling, Validation methods, Cross-validation, Test set, Precision, Recall, Specificity.

UNIT 3: **14 lecture hours**

Bias–Variance trade off, Random Forest models, Gradient Boosting Machines (GBM), Anomaly detection, Forecasting using ARIMA, Deep Learning Analysis with PUBLIC CLOUD, Strategies to Organize Data for Analytics, Linked Analytical Datasets, linking together datasets, Managing data lakes, Data retention strategy, The Economics of IoT Analytics, Cost considerations for IoT analytics, Geospatial Analytics to IoT data.

Text Books:

1. *Minteer, Andrew. Analytics for the internet of things (iot). Packt Publishing Ltd, 2017. ISBN 978-1787120730.*

Reference Books:

1. Geng, Hwaiyu, ed. *Internet of things and data analytics handbook.* John Wiley & Sons, 2017. ISBN 78-1119173649.

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS221	IoT: Security and Attacks	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Explain Security in IoT, IoT Vulnerabilities, Authentication, Authorization.
CO2: Examine attack Models of IoT and Secure Communication Links in IoTs.
CO3: Implement solutions of public cloud IoT security.

Course Contents:

UNIT 1: **12 lecture hours**

Architecture of IoTs, IoT Security Requirements Privacy preservation, Device security, Authentication, Confidentiality, Integrity of IoT devices, Benefits of IoT,IoT Attack Surface, Industrial Standards of IoT device security, Gateway security, IoT Privacy Concerns, Privacy by Design, Conducting a Privacy Impact Assessment, Case Study: The Connected Barbie.

UNIT 2: **14 lecture hours**

IoT Vulnerabilities, Secret-Key, Authentication/Authorization for Smart Devices, Constrained, System Resources, Device Heterogeneity, Fixed Firmware, AttackModels, Layer-wise Attack model, Attacks to Sensors in IoTs, Attacks to RFIDs in IoTs, Attacks to Network Functions in IoT attacks to Back-end Systems, Security in Front-end Sensors and Equipment. IoT Attacks - Side-channel Attacks, Spoofing Attack, Sniffing Attack, Rogue Attack, Devices Attack, Man-in- Middle Attack, DDoS Attack.

UNIT 3: **08 lecture hours**

Securing internet of things environments, Networking Function Security, IoT Networking Protocols, Layering Architecture, Secure IoT Lower Layers, SecureIoT Higher Layers, Secure Communication Links in IoTs, Back-end Security, Secure Resource Management, Secure IoT Databases, IoT Hardware Test, Test Device Range, Latency and Capacity.

UNIT 4: **08 lecture hours**

Manufacturability Test, Secure from Physical Attacks, IoT Software-Trusted IoT Application Platforms, Secure Firmware Updating, Network Enforced Policy, Secure Analytics Visibility and Control.

Text Books:

1. *Liyanage, Madhusanka, An Braeken, Pardeep Kumar, and Mika Ylianttila, eds. IoT security: Advances in authentication. 1st ed. Wiley Telecom, 2020.*

Reference Books :

1. Chantzis, Fotios, Ioannis Stais, Paulino Calderon, Evangelos Deirmentzoglou, and Beau Woods. *Practical IoT hacking: the definitive guide to attacking the internet of things*. 1st ed. No Starch Press, 2021.

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS222	Device Level IoT Security	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate the security issues in IoT.
CO2: To apply the cryptographic techniques in IoT.
CO3: To implement various types of access control mechanism for IoT devices in network environment.

Course Contents:

UNIT 1: **12 lecture hours**

Brief review of the Internet of Things IoT, IoT in business world, Benefits Applications of IoT, Security Issues with IoT, Basic Architecture of IoT, IoT Attack Surface, OWASP Top 10 for IoT. Concept of Vulnerability management, Quarantine and Prevention.

UNIT 2: **14 lecture hours**

Security Requirements in IoT Architecture - Security in Enabling Technologies - Security Concerns in IoT Applications. Security Architecture in the Internet of Things- Security Requirements in IoT - Insufficient Authentication/Authorization - Insecure Access Control - Threats to Access Control, Privacy, and Availability - Attacks Specific to IoT. Vulnerabilities - Secrecy and Secret-Key Capacity- Authentication/Authorization for Smart Devices - Transport Encryption - Attack Fault trees.

UNIT 3: **16 lecture hours**

Cryptographic primitives and its role in IoT, Encryption and Decryption, Hashes, Digital Signatures, Random number generation, Cipher suites, key management fundamentals cryptographic controls built into IoT messaging and communication protocols, IoT Node Authentication, Identity lifecycle, authentication credentials, IoT IAM infrastructure, Authorization with Publish / Subscribe schemes, access control. Concerns in data dissemination, Lightweight and robust schemes for Privacy protection, Trust and Trust models for IoT, self-organizing Things, Preventing unauthorized access, Cloud security for IoT, Cloud services and IoT, offerings related to IoT from cloud service providers, Cloud IoT security controls.

Text Book:

1. Saravanan, Vijayalakshmi, Alagan Anpalagan, T. Poongodi, and Firoz Khan, eds. *Securing IoT and big data: next generation intelligence*. 1st ed. CRC Press, 2020. ISBN 0367432889.

Reference Books :

1. Bhattacharjee, Sravani. *Practical Industrial Internet of Things security: A practitioner's guide to securing connected industries*. 1st ed. Packt Publications, 2018. ISBN 978-17888 2687.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS223	Humanoids	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate the bipedal mechanism of waking and navigation of humanoids.
CO2: To examine visual, gesture, cognitive-based controlling action of humanoid.
CO3: To implement stable gait generation of walking and localization and navigation of humanoid.

Course Contents:

UNIT 1: **14 lecture hours**

Humanoid, Bipedal Humanoid, Kinematics, Dynamics, Stability criteria of Bipedal robot, Zero moment point, Limit Cycle, Poincare Map, 3D Gait generation, Inverted pendulum model of Humanoid, Arm Movement with stability, Dynamics of Arm movement, Walking robot pattern generation, Central pattern generation, Torque control mechanism, Impact recovery, Push Recovery.

UNIT 2: **14 lecture hours**

Touch sensor, sound sensor, Vision sensor, Tactile Sensing, Robot Localization, Monte Carlo localization, Landmark based localization, Detect Landmark, Update landmark, Kalman filter Localization, Tracking: Known initial position, Global Localization: Unknown initial position, Re-Localization: Incorrect known position, Obstacle avoidance, Potential Field, Simultaneous Localization and Mapping (SLAM), Path Planning, Graph Construction.

UNIT 3: **08 lecture hours**

Vision based Edge detection for navigation, Vision based object recognition for Grasping, Shift Algorithm, Human Robot Interactions using Gestures, Hidden Markov model, Gesture creation (using If THEN Rules), Gesture executions.

UNIT 4: **06 lecture hours**

Cognitive robotics, Sub Sumption Architecture, Potential field-based architecture, Human activity recognition using vision, Motion capture/Learning, mimicking behavior from demonstration.

Text Books:

1. *Goswami, Ambarish, and Prahlad Vadakkepat. Humanoid robotics: a reference. Springer Publishing Company, Incorporated, 2018. ISBN 9400760450.*
2. *Nenchev, Dragomir N., Atsushi Konno, and Teppei Tsujita. Humanoid robots: Modeling and control. Butterworth-Heinemann, 2018. ISBN 978-0128045602.*

Reference Books:

1. González Aguirre, David Israel. "Visual perception for humanoid robots: environmental recognition and localization, from sensor signals to reliable 6D poses." *(No Title)*. ISBN 331997839.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS224	Mobile IoT Networks	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate the concepts of Mobile IoT Network systems.

CO2: To examine the routings of mobile IoT Network.

CO3: To implement the applications for the mobile IoT networked embedded systems.

Course Contents:

UNIT 1: **14 lecture hours**

Internet Working, Hosts Communication, Protocol Stacks, IoT Protocols, Intra-domain vs. Inter-domain, X0 Communications Backbone, Network Virtualization, Delivery Methods, Wired Networking, Reference Architectures for IoT, Layer Networking for Nonreworked Embedded Systems, Components of networked embedded systems, Real-time embedded systems, Centralized and distributed embedded systems, Physical sensor, Passive sensor, Semi-passive, Active sensors, Soft sensors, Sensor nodes.

UNIT 2: **14 lecture hours**

Mobile sensor network, Sensor networks with mobile nodes, Power management, Mobile node discovery, Data transfer to mobile nodes, Mobile nodes routing, Distributed Algorithms for IoT, Hierarchical Addressing and Routing, Geographic Addressing and Routing, Delay-Tolerant Networking, Optimized Link State Routing (OLSR), Dynamic Source Routing (DSR).

UNIT 3: **08 lecture hours**

Sockets API Programming, Packet Forwarding, Network Design, IoT forwarding, IoT processing, IoT Isolation for devices, Participatory sensing of Networked Embedded Systems.

UNIT 4: **06 lecture hours**

Vehicular Networked Embedded Systems, Intra -vehicular Network Embedded Systems, Event Triggered Networked Embedded Systems System, Time Triggered Networked Embedded Systems System, Intelligent transportation systems.

Text Books:

1. *Hernández-Callejo, Luis, and Sergio Nesmachnow, eds. Mobility and IoT for the Smart Cities. MDPI-Multidisciplinary Digital Publishing Institute, 2020. ISBN 3039430505.*
2. *Mahmood, Zaigham. "Connected vehicles in the internet of things." Springer Nature SwitzerlandAG (2020). ISBN 3319888870.*

Reference Books:

1. Lea, Perry. *IoT and Edge Computing for Architects: Implementing edge and IoT systems from sensors to clouds with communication systems, analytics, and security*. Packt Publishing Ltd, 2020. ISBN 1839214805.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS225	Emerging Topics in IoT and Robotics	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1. Gain a comprehensive understanding of the fundamentals of IoT and Robotics, including the potential applications and implications of these technologies in the world today.
CO2. Develop the ability to analyze and evaluate current and emerging trends in IoT and Robotics, and to develop strategies to deploy these technologies in a business context.

Course Content:

UNIT 1: **42 lecture hours**

This course will provide an in-depth look at current and emerging topics in IoT and Robotics. We will explore the technological advancements in this field, such as artificial intelligence, machine learning, and deep learning. We will also discuss the ethical implications of these technologies, as well as the challenges and opportunities they present. Additionally, students will gain practical skills in programming, interfacing, and integrating IoT/Robotics components and systems. By the end of the course, students will be well-versed in the fundamentals of IoT and Robotics and have the skills needed to create and implement projects and applications in this field.

Laboratory:

Students will gain practical experience by using tools and technologies related to IoT and Robotics.

RAMA UNIVERSITY UTTAR PRADESH,
KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Specialization Electives: Cloud Computing and DevOps

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS226	Cloud System Administration and Operations	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To get fundamentals of support and maintain cloud workloads as per the cloud architecture.
CO2: To perform operations by using the cloud management console, CLI and SDK.
CO3: To implement architectural requirements with monitoring, logging, and troubleshooting.

Course Contents:

UNIT 1: **14 lecture hours**

Need of cloud administration and operations, Roles and responsibilities of cloud Admin, Inter-cloud Resource Management, Resource Deployment and Provisioning, Identifying the steps to provision cloud resources, Identify, and remediate deployment issues, Storage and Data Management Connectivity services of public/private cloud Automation and Optimization, Manage and assess resource utilization, Employ cost optimization strategies, Automate manual or repeatable process, Minimize management overhead, Monitoring and Reporting, Maintain metrics and alarms utilizing, Recognize and differentiate performance metrics, Availability metrics, Manage security policies on cloud, Access controls when using cloud, Shared responsibility model.

UNIT 2: **12 lecture hours**

Data Centre Management Tools Integration, Service and Resource Management, implement scalability and elasticity, highly available and resilient environments on cloud, automate snapshots, Data Lifecycle Manager, Data Retention policy, Restore databases versioning, Lifecycle rules, Disaster recovery procedures, Cost optimization strategies, Networking and Content Delivery, Performance optimization strategies.

UNIT 3: **16 lectures hours**

OS boot process (Win/Linux) and Troubleshooting: Memory management, Memory pages, Buffer and Caches, System date/time management, Network time protocol, Network Logs Auditing, Managing Users and groups, File permissions, Assessment/Buffer Lecture, managing software, Managing system services, Background processes, Windows start-up tasks Integrated Internet-aware network troubleshooting, Network tools to report the problem, Network address translation, troubleshooting in common VPC, Troubleshooting in On-premises to VPC, System performance – DISK, System performance – Memory, System performance – Network System Login issues, System booting issues System logs, Network connectivity issues

Text Books:

1. *S., Digby, G., Fitch, C., Friedberg, S., Qualheim, S., Rhoads, J and Sundrud, B, AWS Certified SysOps Administrator Official Study Guide: Associate Exam (1 ed.), John Wiley & Sons, 2017. ISBN 9781119377429.*
2. *Chandra Rajasekharaiah, Cloud-Based Microservices: Techniques, Challenges, and Solutions (1 ed.), Apress, 2020. ISBN 9781484265642.*

Reference Books :

1. *Jackson, K. L., & Goessling, Architecting Cloud Computing Solutions: Build cloud strategies that align technology and economics while effectively managing risk (1 ed.), Packt Publishing Ltd, 2017. ISBN 9781788472425.*

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS227	Cloud Security and Compliances	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To learn and examine the security breaches of IaaS, PaaS, and SaaS.
CO2: To apply various data encryption methods and security mechanisms to get the administrative control using IAM service.
CO3: To create a secure production environment using cloud security features and services.

Course Contents:

UNIT 1: **14 lecture hours**
Security Patterns for Cloud Computing – Network Security, Identity & Access Management & Trust, Secure On-Premises Internet Access, Secure External Cloud Connection, Cloud Denial-of- Service Protection, Cloud Traffic Hijacking Protection, Automatically Defined Perimeter, Cloud Authentication Gateway, Federated Cloud Authentication, Cloud Key Management, Trust Attestation Service, Collaborative Monitoring and Logging, Independent Cloud Auditing

UNIT 2: **14 lecture hours**
End-to-end security, Shared responsibility in the cloud, Backup and restore, Detect and mitigate threats, Plan for ransomware, recovering from systemic identity compromise, Threat protection, Securing Workloads, Security technical capabilities, Physical security, Components and boundaries, Operations and Monitoring, Platform integrity and security, Secure Data Protection Law: national and International, Firmware security, Code integrity, Secure Boot, Secure Isolation of Physical & Logical Infrastructure, Compute, Network, Storage, Common attack vectors and threats, Secure Isolation Strategies, Multitenancy, Virtualization strategies.

UNIT 3: **14 lectures hours**
Data Protection for Cloud Infrastructure and Services. Understand the Cloud based Information Life, Cycle, Data protection for Confidentiality and Integrity, Encryption, Data Redaction, Tokenization, Obfuscation, PKI and Key, Management, Assuring data deletion, Data retention, deletion and archiving procedures for tenant data, Data Protection Strategies.

Text Books:

1. *Chen, Lei, Hassan Takabi, and Nhien-An Le-Khac, Security, privacy, and digital forensics in the cloud (1 ed.), John Wiley & Sons, 2019. ISBN 13: 9781119053286.*
2. *Russell, Brian, and Drew Van Duren, Practical Internet of Things Security: Design a security framework for an Internet connected ecosystem (2 ed.), Packt Publishing Ltd, 2018. ISBN 13: 9781788625821.*

Reference Books :

1. *Anthony, Mastering AWS Security: Create and maintain a secure cloud ecosystem (1 ed.), Packt Publishing Ltd, 2017. ISBN 13: 9781788293723.*

2. *Tevault, Donald A, Mastering Linux Security and Hardening: Secure your Linux server and protect it from intruders, malware attacks, and other external threats (1 ed.), Packt Publishing Ltd, 2018. ISBN 1788620305.*

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS228	AWS Cloud Support Associate	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To identify the possible scope of bug, error, and glitch in system.
CO2: To analyse and solve problems for AWS client/user.
CO3: To get expertise in AWS cloud solutions to solve technology challenges.

Course Contents:

UNIT 1: **14 lecture hours**

Setting up AWS accounts, Accessing Methods of AWS Services, AWS Organizations, AWS Cost Explorer, AWS Technical Support, Cloud Billing and Support, AWS Well-Architected Framework Well-Architected Design Principles, Choosing a Region, Selecting Availability Zones, Virtual Private Cloud, Dividing VPCs and Subnets, Default VPCs and Default Subnets, Controlling VPC Traffic, Connecting Multiple VPCs, Integrating On-premises Components, Load Balancing and Fault Tolerance, High Availability Across Regions, Connections Outside of Amazon VPC, Designing for High Availability CLOUD Solution, Scaling Data Stores, AWS Lambda and Event- Driven Scaling, Manual AWS Environment Configuration, Infrastructure as code on AWS, Grouping resources in a template, Automating AWS Infrastructure.

UNIT 2: **14 lecture hours**

Loose Coupling, Loose Coupling Strategies, Communicating Easily and Reliably Among Components, Communicating with Loose Coupling and Amazon DynamoDB, Amazon API Gateway, Serverless Architectures, Decoupling Infrastructure, Storing Web-Accessible Content with Amazon, Caching with Amazon CloudFront, Managing NoSQL Databases, Storing Relational Data in Amazon RDS, Designing Web-Scale Media, Scalable Web Application, Operational Excellence Pillar, Security Pillar, Reliability Pillar, Performance Efficiency Pillar, Cost Optimization, High- Availability Design Patterns, Stream Processing Example, Sensor Network Data Ingestion and Processing, Application Backend, Transcoding and Serving Video Files Example, Dedicated Instances and Dedicated Hosts, Trusted Advisor, Optimizing Costs with Caching, AWS Cost Calculation Tools, Amazon CloudWatch, Amazon CloudWatch Monitoring, Amazon CloudWatch Events, Amazon CloudWatch Logs, AWS CloudTrail, AWS Service Integration with Amazon Athena, AWS Config, Elastic Load Balancing, Amazon EC2 Auto Scaling.

UNIT 3: **14 lectures hours**

Amazon Route 53, Amazon Route 53 Routing, Configure EC2 Auto Scaling, Configure Failover Routing with Amazon Route 53, Continuous Integration and Continuous Deployment on AWS, AWS Developer Tools and Services, Database Cluster on Amazon Aurora, Amazon DynamoDB, AWS Database Migration Service (AWS DMS), Migrate to Amazon RDS, Tagging, AWS Trusted Advisor, Managing Resources, Optimize AWS Resource Utilization, Features of AWS Support plans, creating support cases and case management, Monitoring, resolving, and reopening the ticket/case, Access permissions for AWS Support, changing your AWS Support plan, Using AWS Support with an AWS SDK.

Text Books:

1. *Piper, Ben, and David Clinton, AWS Certified Solutions Architect Study Guide: Associate SAA-C02 Exam (1 ed.), John Wiley & Sons, 2020. ISBN 978-1119138556.*

Reference Books :

1. S Wadia and Yohan, *AWS Administration–The Definitive Guide* (2 ed.), Packt Publishing Ltd, 2016. ISBN 9781782173755

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Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS229	Developing Solutions for Microsoft Azure	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate Azure IaaS, PaaS, and SaaS solutions.
CO2: To develop the applications using Azure services integration.
CO3: To deploy, operate, and monitor Azure solutions.

Course Contents:

UNIT 1: **16 lecture hours**

Setting up Azure accounts, Azure Console Walkthrough, Microsoft Azure Services, Azure CLI, Azure PowerShell, Configuring Azure CLI, Azure Resources & Subscriptions, Azure Resource Manager, Azure Tags, Azure Storage Account & its types, Azure Blob Storage Azure Content Delivery Network (CDN), Azure Files Storage, Azure File Sync, Azure Table Storage, Azure Queue Storage, Azure Storage Explorer, Azure Shared Access Signature (SAS), Azure Databox, Azure Storage Replication Data replication options, Azure Import/Export Service, Azure virtual machines, Data disks in Azure Azure VMs and interfaces, ARM templates, VHD templates, Custom images of Azure VM, Virtual machine scale sets, Virtual machine availability sets, App Service Web App for containers, App Service plan, Networking for an App Service, Deployment slots, Container image.

UNIT 2: **14 lecture hours**

Azure Kubernetes Service, Azure Container Registry, Azure virtual networks, Azure VNet Components, Azure VNet subnets, Azure Network Interface Cards (NIC), Network Security Groups (NSGs), Route tables, Service tags, Azure DNS, Private DNS, Application Gateway, Azure Front door Service, Azure Traffic Manager, Application Security Groups, Azure Load Balancer, Azure, ExpressRoute, ExpressRoute Circuits, ExpressRoute Peering, Azure Firewall, Azure Bastion, Network Watcher, Identity and Access Management in Azure, Role-based Access Control (RBAC), Role definitions, Role assignment in Azure resources, Azure users and groups, RBAC policies.

UNIT 3: **12 lectures hours**

Microsoft azure active directory, Azure Monitoring and Autoscaling, Azure Data Platform, Azure Migration, Server-side programming model, Triggers, User-defined functions (UDFs), Table API, Cosmos DB graph database, populating a graph, Writing Gremlin queries, Azure Table Storage, integrate caching and content delivery, Configure cache and expiration policies for Azure Redis Cache Connections, App Configuration Azure Key Vault, Key Encryption, expiration.

Laboratory:

Studio work covers accessing Azure cloud services with handling data migration based on provided architectural requirements using Azure migrate service. Learners would be able to create and migrate Azure virtual machines and create storage accounts and application gateways for aiding Azure Migrate. They will also develop the applications using Azure services by using cloud architecture.

Text Books:

1. *Orban and Stephen, ahead in the Cloud: Best Practices for navigating the Future of Enterprise IT (1 ed.), CreateSpace Independent Publishing Platform, 2018. ISBN 9781981924318.*
2. *Modi, Ritesh, Azure for Architects: Implementing cloud design, DevOps, containers, IoT, and serverless solutions on your public cloud (2 ed.), Packt Publishing Ltd,, 2019. ISBN 9781788398732.*

Reference Books :

1 *Benjamin Perkins and William Panek, Microsoft Azure Architect Technologies, and Design Complete Study Guide: Exams AZ-303 and AZ-304 (1 ed.), Wiley Publication, 2020. ISBN 9781119559573.*

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS230	Google Associate Cloud Engineer	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1 : To articulate the Google cloud services and platform
CO2 : To integrate cloud resources and services using Google cloud.
CO3 : To develop, deploy and monitor secured cloud-based solution on the GCP Platform

Course Contents:

UNIT 1: **14 lecture hours**

Setting up cloud projects and accounts, creating projects in GCP, Viewing Google Cloud Platform Status Cloud Console, Cloud Shell, Cloud SDK, Configuring access and security, Assigning users to predefined IAM roles within a project, Managing users, groups, and roles in Cloud Identity, Enabling APIs within projects, Provisioning one or more Stack driver workspaces, Managing billing configuration, Creating one or more billing accounts, Linking projects to a billing account, Establishing billing budgets and alerts, Setting up billing exports to estimate daily/monthly charges, Billing Services, Configuring the command line interface (CLI), Accessing services using CLI, Working with GCP SDK, Integration of GCP Platform with other Cloud Services.

UNIT 2: **14 lecture hours**

Planning and estimating GCP product use, Pricing Calculator, Planning and configuring compute resources, Selecting appropriate compute choices for workload, Compute Engine (20) Google Kubernetes Engine, App Engine, Power Shell, Cloud Functions, Deploying and implementing Compute Engine resources, deploying a Google Kubernetes Engine cluster, Planning and configuring network resource, Load balancing options, Identifying resource locations in a network for availability, Configuring Cloud DNS, Deploying a container application to Google Kubernetes Engine, Auto Scaling in Google Kubernetes, Handling Fault Tolerance in Google Kubernetes.

UNIT 3: **14 lectures hours**

Deploying and implementing data solutions, Cloud SQL, Cloud Datastore, Big Query, Cloud Spanner, Cloud Pub/Sub, Cloud Bigtable, Cloud Dataproc, Cloud Dataflow, Cloud Storage, Loading data, Deploying and implementing networking resource, Monitoring and logging, Creating Stack driver alerts based on resource metrics, Creating Stack driver custom metrics, configuring log sinks to export logs to external systems, Viewing and filtering logs in Stackdriver, Viewing specific log message details in Stack driver, Cloud diagnostics, Cloud Trace data, Cloud Debug to view an application point, Case Study.

Laboratory:

Studio work focuses on the Google Cloud platform of deploying, monitoring, and maintaining projects on Google Cloud.

Text Book:

2. *Legorie Rajan, Steven Porter, and Ted Hunter, Building Google Cloud Platform Solutions (1 ed.), Packt Publishing, 2019. ISBN 97818386474382.*

Reference Books :

1. *Legorie Rajan, Steven Porter, and Ted Hunter, Building Google Cloud Platform Solutions (1 ed.), Packt Publishing, 2019. ISBN 97818386474382.*

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS231	Software Containerization in DevOps	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1 : To articulate the software containerization with virtual machines.

CO2 : To examine the need for Manipulation, Coordination and Orchestration Tools for a large production environment.

CO3 : To implement Containers and Image Operations along with Container Networking.

Course Contents:

UNIT 1: **08 lecture hours**

Containerization and Virtualization, Virtual Machine (VM), Hypervisor and its types, Architecture of VM, Architecture of Container, Docker Engine, Difference between Containers and Virtual Machines.

UNIT 2: **08 lecture hours**

Container Manipulation, Container's Providers Examples, Cloud Platforms using Containers, Multiple, Scalability, Portability of Containers, Orchestration, Architecture of Orchestration, Container Orchestration, Cloud Platforms using container orchestration, Container Operations, Image Operations Running Multiple Containers, Custom Image in Containers.

UNIT 3: **12 lectures hours**

Creation of Custom Image, Need and Benefits of Custom Image, Running Container using Custom Image, Publishing of Custom Image, The Chroot System, FreeBSD Jails, Linux Containers, Docker architecture, Docker Daemon (Container Platform), Docker Rest API, Industries using Dockers, Networking, Container Networking, Architecture of Container Network, Types of Container Networking, Use of Container networking in Web-Scale Applications.

UNIT 4: **14 lectures hours**

OpenShift Enterprise, OpenShift Features, OpenShift in DevOps, Providers of OpenShift, OpenShift in DevOps, Providers of OpenShift, Container and Microservices, Kubernetes, Kubernetes on cloud, Docker Swam and Kubernetes, Deployment of Containers, Monitoring of containers, Elastic Container Service providers (AWS, Azure).

Text Book:

1. *Panthofer Mark, Mastering Docker Enterprise: A companion guide for agile container adoption (1 ed.), Packt Publishing,, 2019. ISBN 978-1789612073.*

Reference Books :

1. Rice Liz, *Container Security: Fundamental Technology Concepts that Protect Containerized Applications (1 ed.),* O'Reilly Media, 2020. ISBN 978-1492056706.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS232	Build and Release Management in DevOps	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To explain the build and release management cycle in DevOps.

CO2: To examine the Assess packages, repositories, needs, and usage.

CO3: To experiment with building a management tool for dependency management.

Course Contents:

UNIT 1: **10 lecture hours**

Build and Release Management Overview: Overview of Build Management, Build Abstraction, Overview of Packaging Management, Packaging repositories, Package Registries using the Package, Package Manager Vs Package Management, Package Management Tools.

UNIT 2: **12 lecture hours**

Build and Release Concept and Process, release management, Overview of Release and Deployment Management, Objective and Benefits, Key terminologies used in Release Management, working of Release Management, Release Management Process Components, Release Lifecycle Management, Change management, Need of change management, Change Management Vs Release Management.

UNIT 3: **10 lectures hours**

Declarative Dependency Management, Dependency Management and Build Tools, Repositories, Dependency Identification, Transitive Dependencies, Dependency Scope, Tools (Maven, Ant and Gradle) introduction, Apache Ant Fundamental, Apache Maven Fundamental, Apache Maven Advance, MsBuild Fundamental, Gradle Fundamental.

UNIT 4: **10 lectures hours**

Documentation and Reporting: Documentation Vs Technical Documentation, Different Types of Documentation, General Practice in Documentation, Agile and Waterfall Approaches, Tools used for Documentation, System Vs User Documentation, Discuss Some samples/Templates used in General for Software Documentation.

Text Book:

1. *Blokdyk Gerardus, Change and Release, Management A Complete Guide (1 ed.), 5STARCooks, 2021. ISBN 978-1867310242.*

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS233	Cloud Services Development and Operations	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate service API Gateway and using of serverless computing.
CO2: To build, test and integrate cloud services.
CO3: To deploy, operate and maintain the secure cloud service solution.

Course Contents:

UNIT 1: **14 lecture hours**

Systems Development Lifecycle, Workflow for developing cloud application on public clouds, Cloud Software Development Kit (SDKs), SDK Terminology, Cloud Testing Service, Errors and Exceptions, Cloud Service developing tools, Storage Solutions with public cloud, Developing NoSQL Solutions with public cloud platform, Caching Information for Scalability.

UNIT 2: **14 lecture hours**

Cloud notification services, Message Queueing Service, Events Processing with Serverless computing service, Implementation and Authentication using Serverless computing, Serverless best Practices, Serverless Step Functions, Secure network Connections, manage applications secrets, Authenticate with security token, Cognito for user sign-up and sign-in to the web and mobile app, Container, Container Management.

UNIT 3: **14 lectures hours**

Configure auto-scaling, launch auto-scaling, Self-healing Kubernetes cluster, Deploy the microservices using Kubernetes cluster, Cloud service registration, Cloud service discovery, configure scaling and self-healing for each service, best practices for debugging, Microservices, Monitoring and Logging for microservices, Case Study of resilience cloud service.

Laboratory:

The lab objectives are to test serverless applications, minimize risk of vendor lock-in, create multiple stages of our API and improve security and observability of our application on cloud platform.

Text Books:

1. *Stephen Orban, Ahead in the Cloud: Best Practices for navigating the Future of Enterprise IT (1st ed.), CreateSpace Independent Publishing Platform, 2018. ISBN 9781981924318.*
2. *Wadia and Yohan, AWS Administration–The Definitive Guide (1st ed.), Packt Publishing Ltd, 2016. ISBN 9781782173755.*

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS234	Source and Version Control in DevOps	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate the technical aspects of Source and Version Control systems in DevOps

CO2: To examine the version control systems for tracking, branching, merging, and managing code revisions.

CO3: To make use of the workflows of various version control systems like Git, Sun and Mercurial.

Course Contents:

UNIT 1: **12 lecture hours**

Source Version Control (SVC), SVN (Sub Version Systems), Mercury and Git, Single Source repository, Creation, Commit, Builds, Cloud Computing, Version Control Over Cloud, Implementation of Version control over cloud, copy-merge and merge -update algorithms, Practices and rules of version control systems, Industries using version control system (Case study).

UNIT 2: **14 lecture hours**

Distributed Version Control System (DVCS), DVCS Vs CVS, Local Repository, Advantages of Distributed version Control System, Local repository operations (Resetting Local Environment, Revert - Cancelling Out Changes, Private Workspace), Multiple Repositories Models, Repositories for Different Services, Merging Repositories, Branching Repositories, Automation of SVC, BitBucket SVC on cloud, BitBucket SVC on local system.

UNIT 3: **10 lectures hours**

Continuous Integration and Continuous Deployment (CICD), CI Models, CI Practices over SVC, Operations of CI over SVC, Automated CI over SVC, CD over SVC, CD Models, CD Practices over SVC, Operations of CD over SVC, Automated CD over SVC, CICD Tool.

UNIT 4: **06 lectures hours**

Git Basics and Remote Repositories, BitBucket Server and its working, Security over BitBucket, Creation of Projects over BitBucket.

Text Books:

1. *Gerardus Blokdyk, Distributed Version Control System A Complete Guide (1st ed.), 5STARCooks, 2021. ISBN 978-1867331193.*
2. *Leornardo Christian, Git: A fast and easy guide to version control (1st ed.), Independently published, 2020. ISBN 979-8642660034.*

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	**Bachelor of Technology (Computer Science and Engineering)**				
BCSS235	**Continuous Integration and Deployment in DevOps**	L	T	P	C
Owning School/Department	**Computer Science and Engineering**	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Describe the core concepts of DevOps, CI/CD, and the role of automation in modern software delivery.
CO2: Set up and manage Continuous Integration pipelines using tools like Jenkins, GitHub Actions, or GitLab CI.
CO3: Implement Continuous Deployment strategies and automate deployment using containerization and orchestration tools.
CO4: Integrate testing, monitoring, and feedback mechanisms into CI/CD pipelines for reliable delivery.

Course Contents:

UNIT 1: **08 lecture hours**

DevOps principles and practices, DevOps vs traditional development, DevOps lifecycle, culture of collaboration, automation in DevOps, overview of Continuous Integration and Continuous Deployment, benefits and challenges of CI/CD.

UNIT 2: **10 lecture hours**

Version control with Git, Git workflows (feature branches, GitFlow), Introduction to CI tools: Jenkins, GitHub Actions, GitLab CI, configuring build jobs, automated builds and test execution, YAML configurations, integration with repositories, code quality checks (SonarQube, linters).

UNIT 3: **12 lecture hours**

Deployment strategies (blue-green, canary, rolling), Infrastructure as Code (IaC) with tools like Terraform and Ansible, Docker basics, creating and using Dockerfiles, using Docker Compose, container registries, Kubernetes basics, automating deployments to cloud platforms.

UNIT 4: **12 lecture hours**

Automated testing types (unit, integration, acceptance), test automation frameworks (JUnit, pytest, Selenium), integrating tests in CI/CD, monitoring and alerting tools (Prometheus, Grafana), logging practices, feedback loops, CI/CD pipeline optimization, security in pipelines (DevSecOps).

Text Books:

1. **"The DevOps Handbook"** by Gene Kim, Jez Humble, Patrick Debois, John Willis — IT Revolution Press
2. **"Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation"** by Jez Humble and David Farley — Addison-Wesley

Reference Books:

1. **"Learning DevOps: Continuously Deliver Better Software"** by Mikael Krief — Packt Publishing
2. **"Kubernetes Up & Running"** by Kelsey Hightower, Brendan Burns, Joe Beda — O'Reilly Media
3. **"Infrastructure as Code"** by Kief Morris — O'Reilly Media
4. Official Documentation: Jenkins, GitHub Actions, Docker, Kubernetes, Terraform

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS236	Software Craftsmanship in DevOps	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1 : To articulate the concept of Software Craftsmanship
CO2 : To examine the concept of software documentation, structure, testing and validation.
CO3 : To implement the rules and principles of software craftsmanship.

Course Contents:

UNIT 1: **14 lecture hours**

Software Craftsmanship, Four Dimensions of Quality, Software Ethics, Clean code, Craftsmanship Vs Engineering, Frameworks and Tools, Design, Structure, Formatting, and Documentation of Code, Types of Designs/Models, Design Structure Matrix (DSM), Product-Service System using DSM.

UNIT 2: **08 lecture hours**

Process Documentation, Product Documentation, Different Phases of Design, Requirement of Documentation, Advantages of Documentation, Technical and Non-Technical Challenges in Code Documentation, Content Authoring, Formatting, Styling, Issue Tracking, Testing, Publishing, Documentation: Testing, Debugging, Refactoring Improving Structure.

UNIT 3: **12 lectures hours**

Testing and Validation, Different Types of Testing, Properties of Testing, Customizable, Extendable, Link Validity, Component Checking, Semantic, and Syntax Parsing.

UNIT 4: **08 lectures hours**

Frameworks, Tools, and the Programming Process, DevOps Frame Definition, Agile Framework, Scaled Agile Framework, Adoption Framework, Industry Practices.

Text Book:

1. *Fowler Martin, Refactoring: Improving the Design of Existing Code (2nd ed.), Addison- Wesley, 2019. ISBN 978-0134757599.*

2. *Martin Series Robert C., Software Craftsman, The: Professionalism, Pragmatism, Pride 1st Edition (1st ed.), Addison Wesley, 2020. ISBN 978-0134052502.*

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	**Bachelor of Technology (Computer Science and Engineering)**				
BCSS237	**System Provisioning and Configuration Management in DevOps**	L	T	P	C
Owning School/Department	**Computer Science and Engineering**	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To explain the system provisioning and configuration management.
CO2: To examine the various configuration tools and their suitability.
CO3: To implement and use of configuration management tools.

Course Contents:

UNIT 1: **08 lecture hours**
Overview of Provisioning: Introduction and Significance of Provisioning. Need and Role of Provisioning under DevOps Model, Provisioning Vs Configuration, Infrastructure Provisioning and its Tools, Environment Provisioning., Automated Provisioning.

UNIT 2: **10 lecture hours**
Overview of Configuration Management: Introduction of Configuration Management, Basic Terminologies of Configuration Management, Server, Nodes, Workstation, Workstation Setup, Organization Setup, Test Node Setup, Benefits of Configuration Management Severs, Configuration Management Tools, Features and Comparison of Configuration Management Tools, Selection Criteria of Tools.

UNIT 3: **12 lectures hours**
Configuration Management & Tools (Puppet, Chef, Ansible, and Saltstack): Puppet Definition, Working, Architecture, Master and Agents, Installation and Configuration of Puppet, Ansible Definition, Ansible Requirement Specification, Ansible Components, Ansible Strategy, Saltstack Introduction, Important Features of Saltstack, SaltStack Enterprise and Salt Open-Source Software Versions, Salt vs. Ansible, Puppet.

UNIT IV: **12 lectures hours**
Application Configuration: Introduction to ConfigMaps and Secrets, Application Configuration with ConfigMaps and Secrets, Creating Config Map, Environment Specific Config, Creating Secrets, Setting Environment for Secrets. Pods Overview: Introduction to Pod, Pod Specification, Pod Lifecycle, Launching Pods, Pods Operation, Pods and Containers, Pods and Controllers, Pods Template, Resource Sharing and Communication: Storage and Networking in Pods, Static Pod.

Text Book:

1. *Freeman James and Jesse Keating, Mastering Ansible: Effectively automate configuration management and deployment challenges with Ansible 2.7 (1st ed.), Packt Publishing, 2019. ISBN 978-1789951547.*

Reference Books :

1. *Verona Joakim, Practical DevOps (2nd ed.), Packt Publishing, 2018. ISBN 978-1788392570*

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS238	Test Automation in DevOps	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate the various testing approaches.
CO2: To examine the automation testing technologies through tools.
CO3: To make use of various automation test cases under DevOps environments.

Course Contents:

UNIT 1: **08 lecture hours**

Test Automation Manifesto and Testing: Test Automation Use cases, Principles, SDLC vs STLC, Testing Life Cycle, Usability Testing, Functional Testing, non-functional testing, End to End Testing, Compatibility Testing, GUI Testing, API testing, Usability Testing.

UNIT 2: **10 lecture hours**

Testing Approaches and Test Cases Design: Manual Testing, Automation Testing, UNIT Testing, Integration Testing, System Testing, Acceptance Testing, Smoke-Sanity Testing, Regression Testing, Test Scenario, Test Case Design, Test Basis, Traceability Matrix.

UNIT 3: **12 lectures hours**

DevOps Testing Best Practices, Business Test Automation, Technical Test Automation, Non-Functional Test Automation, Functional Test Automation, Different Test Automation Tools (Kobiton, Ranorex, Zeuz, etc.).

UNIT 4: **12 lectures hours**

Mobile Automation and Cloud Testing: Mobile Automation and its Requirement, Application and Role of DevOps in Mobile Automation, Cloud Testing, Cloud Testing Setup, Intelligent Test Agents. Continuous Testing, Continuous Testing Requirement and its Advantages, Continuous Testing Strategy, Continuous Delivery, Continuous Testing Vs Continuous Delivery.

Text Book:

1. *Wolfgang Platz and Cynthia Dunlop, Enterprise Continuous Testing: Transforming Testing for Agile and DevOps (1st ed.) (1 ed.), CreateSpace Independent Publishing Platform, 2019. ISBN 978- 1699022948.*

Reference Books :

1. *Arnon Axelrod, Complete Guide to Test Automation (1 ed.), Apress, 2019. ISBN 978-1484238318.*

RAMA UNIVERSITY UTTAR PRADESH,
KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Specialization Electives: Cyber Security

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS239	Cyber Security with Blockchain	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate the cyberthreat landscape and Security Challenges.

CO2: To build Blockchain-based apps for authentication and for storing DNS entries.

CO3: To implement various decentralized applications using blockchain to provide various security services.

Course Contents:

UNIT 1: **12 lecture hours**

Cyber Security, Internet Governance – Challenges, Constraints, Threats, Cyber Warfare, Cyber Crime, Terrorism, Espionage, Need for a Cyber Security Policy, Nodal Authority requirement, Requirement of an International Convention on Cyberspace, CIA model, Cyber Security vulnerabilities, Cyber Security attacks.

UNIT 2: **12 lecture hours**

Security services, Blockchain on the CIA Security Triad, Authentication mechanisms, Two-Factor Authentication with Blockchain, PKI Infrastructure, Deploying PKI-Based Identity with Blockchain, IPNS, Blockchain-Based DNS Security Platform, Deploying Blockchain-Based DDoS Protection, EIP Block for DDoS attacks, Security related issues in smart contracts development, Smart contract testing.

UNIT 3: **10 lecture hours**

Exception handling, debugging of applications, Formal verification, smart contracts security Oyente, why3 for smart contracts, Solgraph based formal verification, implications of blockchain technology for digital privacy, implication for Security, Membership and Access control in Fabric, authentication in fabric network.

UNIT 4: **08 lecture hours**

Privacy in Fabric, Channel encryption, Blockchain Security (Fabric SideDB), Security of a ledger, anonymity, pseudonymity, blockchain Implementation Challenges, privacy law applicability, startups in blockchain based cyber security applications.

Text Book:

1. *Gupta R., Hands-on cybersecurity with blockchain (1 ed.), Packt Publishing, 2018. ISBN 978-788990189.*

Reference Books :

1. Yuan Michael Juntao, *Building Blockchain Apps* (1 ed.), Pearson Education, 2020. ISBN 978-9390168385.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS240	Malware Analysis for Mobile Devices	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To possess the skills to carry out independent analysis of modern malware samples.
CO2: To understand and analyse the Mobile application threat landscape.
CO3: To Apply techniques to unpack, extract, decrypt, or bypass in future malware samples.

Course Contents:

UNIT 1: **12 lecture hours**

Mobile Operating- System and Threats, Mobile Development Tools, Risky Apps, Looking Closer at Mobile Apps. Malware Threats, Hoaxes, and Taxonomy- FakePlayer, DroidSMS, FakeInst, TapSnake, SMSReplicator, Geinimi, ADRD, Pjapps, AirPush, Boxer, GGSmart, Defender, DriveGenie, Torec.

UNIT 2: **10 lecture hours**

Open-Source Tools- Locating and Downloading Mobile Packages, Vulnerability Research for Mobile OS, Antivirus Scans, Static Analysis, Linux File Command, APK, Key tool Key and Certificate Management Utility, Sandbox Analysis, Emulation Analysis, native Analysis, Reverse Engineering, Memory Analysis.

UNIT 3: **12 lecture hours**

Static Analysis, Collections and Marketplace, Marketplace Mirrors and Cache, Contagio Mobile, File Data, Cryptographic Hash Types and Queries, Metadata, Antivirus Scans and Aliases, Certificate Information, Permissions, Strings, Mobile Malware Evolution, detecting malware behaviour, Mobile Malware Trends and Reversing Tactics.

UNIT 4: **10 lecture hours**

Behavioural Analysis, AVD, Component & IPC security, Android app permissions, Network Architecture for Sniffing in a Physical Environment, Traffic analysis and manipulation, Application dynamic runtime analysis, identifying code level vulnerabilities.

Text Books:

1. *Sikorski M. and A. Honig, Practical Malware Analysis (1st ed.), Practical Malware Analysis, 2017. ISBN 978-1593272901.*
2. *Mohanta Bhijit an Anoop Saldanha, Malware Analysis and Detection Engineering a Comprehensive Approach to Detect and Analyze Modern Malware (1st ed.), Packt Publishing, 2022. ISBN 9781484261927.*

Reference Books :

1. Kleymenov Alexey, and Amr Thabet, *Mastering Malware Analysis* (1st ed.), Packt Publishing, 2019. ISBN 9781789614872.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS241	Modern Cryptography	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To comprehend and implement various cryptographic algorithms to protect confidential data.
CO2: To identify network vulnerabilities and apply various security mechanisms to protect networks from security attacks.
CO3: To make use of security tools to locate and fix security leaks in a computer network/software.

Course Contents:

UNIT 1: **14 lecture hours**
Modular arithmetic, Modular Polynomial Arithmetic, Divisibility and greatest common divisors, Euclidean Theorem, Random Number Generator, Pseudorandom Number Generator, Prime numbers, unique factorization, finite fields, Powers and primitive roots in finite fields, Fermat's theorem, Euler's theorem, Symmetric ciphers (Difference between symmetric and asymmetric), Monoalphabetic ciphers (Caesar cipher, Affine cipher, Additive cipher).

UNIT 2: **14 lecture hours**
Polyalphabetic cipher (Playfair cipher, Vigenère cipher) hash functions, authentication and key establishment, Message Authentication Codes (MACs), digital signatures, PKI. Block Ciphers (Feistel Ciphers), Numerical of Feistel Ciphers, Data Encryption standards 8-bit, Discrete Logarithms, Logarithms for Modular Arithmetic.

UNIT 3: **14 lecture hours**
Data encryption standards 64 bits, Advanced encryption standards, Diffie Hellman Key Exchange Algorithm. Euclid Algorithm, Extended Euclid Algorithm, RSA Algorithm. Message Authentication and Hash Functions. Information Theory, Elliptic curves, Elliptic curves over finite fields, The elliptic curve discrete logarithm problem, Elliptic curve cryptography, Lenstra's elliptic curve factorization algorithm, Hash Algorithm-SHA, MD5. Digital Signature Algorithm and Authentication, Authentication Applications KDC, RSA digital signatures, El Gamal digital signatures, GGH lattice-based digital signatures.

Text Book:

1. Stallings William, *Network Security Essentials* (4th ed.), Prentice Hall, 2018. ISBN 978-9352866601

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS242	Vulnerability Analysis in Network Protocols	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To understand the vulnerabilities of network protocols.
CO2: To examine penetration testing on each network protocol for vulnerability detection.
CO3: To make use of tools for detecting vulnerabilities in OSI layers.

Course Contents:

UNIT 1: **06 lecture hours**

OSI model and TCP/IP suite, Layer wise security issues, Network Access Layer Vulnerabilities, Wiretaps, Reconnaissance, Hardware Breakage, Voltage Fluctuations, natural Disaster, Misconfigurations and Malfunctioning of Network Interface Cards, Signal Disruption Attacks.

UNIT 2: **10 lecture hours**

Absence of VLANs, Network Layer Protocol Vulnerabilities, IPv4 Packet Structure and Vulnerabilities, IPv4 Header Based Modification Attack, IPv4 flooding Attack, Man in the Middle Attack by Manipulating IPv4 , IPv6 Security Issues IPSec and its Key Management, ICMP Packet Structure and Working, ICMP Header based Modification Attack, Ping of Death, Countermeasures for Each Attack in Network Layer Protocol, Attacks on Routers and Routing, RIP, OSPF, BGP, Countermeasures of Attacks.

UNIT 3: **12 lecture hours**

Transport Layer Protocol Vulnerabilities, TCP Packet Structure and its Working, TCP Header Based Modification Attacks, TCP Incomplete Connection Attack, TCP SYN Flooding Attack, TCP Reset Attack, TCP Session Hijacking Attack, Reverse Shell Attack, Detection and Countermeasures of Each type of TCP Attack, UDP Packet Structure and its Working, UDP Header Based Modification Attack, UDP Generic Flooding Attack, Detection and Countermeasures of Each type of UDP Attack.

UNIT 4: **14 lecture hours**

Application Layer Protocol Attacks, DHCP Packet Structure and Working, Classic DHCP Starvation Attack, Induced DHCP Starvation Attack, DHCP Spoofing Attacks, DHCP Flooding Attacks, Countermeasures for each attack on DHCP, DNS Packet Structure and Working, DNS Cache Poisoning for Phishing, Domain Hijacking DNS Flooding, Reflection and Amplification Attack, Random Subdomain Attack, NXDomain and Phantom Domain Attack, Countermeasures for each attack on DNS, HTTP Packet Structure and its Working, Method based Flooding Attacks, HTTP Half Connection Attack, HTTP fuzzers and misbehaved fields, Cache bypassing attacks, Countermeasures for each attack on HTTP, Wireless Access Point Firmware Vulnerabilities, SSID Beaconing and Checking for Hidden and Fake Wireless Networks, Brute Force Attack, Evil twin Attack, WiMax vulnerability, Vulnerability of zigbee protocols.

Text Books:

1. *Sanders C., Practical Packet Analysis (3rd ed.), No Starch Press, 2017. ISBN 9781593278020.*

Reference Books :

1. Gebali F., *Network Vulnerability Assessment: Identify security loopholes in your network's infrastructure* (1st ed.), Springer, 2018. ISBN 978-1788627252.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS243	Penetration Testing, Auditing and Ethical Hacking	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To identify and analyze the stages an ethical hacker requires to compromise a target system.
CO2: To utilize tools and techniques to carry out a penetration testing.
CO3: To critically evaluate security techniques used to protect system and user data.

Course Contents:

UNIT 1: **14 lecture hours**

Penetration Testing Concepts, Plan a Pen Test Engagement, Rules of engagement, Communication escalation path, Resources and requirements, Budget, Impact analysis and remediation timelines, Disclaimers, Technical constraints, Support resources, Key legal concepts, Contracts, Environmental differences, Written authorization, Scope and Negotiate a Pen Test Engagement, Prepare for a Pen Test Engagement, Conducting Passive Reconnaissance, Information gathering, Perform Social Engineering Tests, Perform Physical Security Tests on Facilities.

UNIT 2: **16 lecture hours**

Active Reconnaissance, Scan Networks, Enumerate Targets, Analyzing Vulnerabilities, Exploiting Cross-Site Scripting, Cross-Site Request Forgery, Web Application Exploitation, File upload vulnerability , HTTPS Requests: Get & Post , Using Burp as a Proxy Server, Code Execution Vulnerabilities, Countermeasures, Penetrating Networks, Exploit Network-Based Vulnerabilities, Exploit Wireless and RF-Based Vulnerabilities, Evil twin, Karma attack, Downgrade attack, De-authentication attacks, Fragmentation attacks, Credential harvesting, WPS implementation weakness, Bluejacking, Bluesnarfing, RFID cloning, Jamming, Repeating, Local File Inclusion Vulnerabilities, Getting Shell from LFI Vulnerability, OSINT Tools, Maltego, Shodan, Google Dorks, The Harvester, Metagoofil, TinEye.

UNIT 3: **12 lecture hours**

Analyze Pen Test Data, Reporting Pen Test Results, Write and Handle Reports, Normalization of data, Written report of findings and remediation, Risk appetite, Storage time for report, Secure handling and disposition of reports, Conduct Post-Report-Delivery Activity, Post-engagement cleanup, Removing shells, Removing tester-created credentials, Removing tools, Client acceptance, Lessons learned, Follow-up actions/retest, Attestation of findings, Develop Recommendations for Mitigation Strategies, Solutions, Findings, Remediations.

Text Books:

1. *Harper Allen, Gray Hat Hacking: The Ethical Hacker's Handbook (6th ed.), McGraw-Hill Osborne Media, 2022. ISBN 1264268947.*

Reference Books :

1. Wallace Connor, *Penetration Testing: Penetration Testing: A Hands-On Guide For Beginners* (1st ed.), Independently Published, 2020. ISBN 979-8614981143.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS244	Forensics and Cyber Law	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To understand the Volatile Data Collection from Windows system.
CO2: To understand cyber activities which are considered as crime in India.
CO3: To apply forensic analysis in Computer Investigations.

Course Contents:

UNIT 1: **10 lecture hours**

Cyberspace and Criminal Behaviour, Traditional Problems Associated with Computer Crime, The Emergence of e-Cash: A New Problem for Law Enforcement. Hacking, Intellectual Property, Web-Based Criminal Activity, Theft of Information, Data Manipulation, Web Encroachment, Cyberterrorism, Dissemination of Contraband or Offensive Materials, Threatening and Harassing Communications, Money Laundering, Online Fraud, Identity Theft/Fraud, Victimology, Virtual or Internet-Facilitated Methods, Data Piracy and Counterfeit Goods, Volatile Data Collection from Windows system, Volatile Data Collection from Unix system.

UNIT 2: **10 lecture hours**

Computer Fraud and Abuse Act of 1986, national Information Infrastructure Protection Act of 1996 (NIIPA), Evolving Child Pornography Statutes, Identity Theft and Financial Privacy Statutes, Law Enforcement Operations and Tools in the United States, Computer-Related Crime of the Council of Europe, Council of Europe's (CoE) Cybercrime Conventions, Law to Child Pornography Statutes, Unlawful Internet Gambling Enforcement Act of 2006, Electronic Communications Privacy Act of 1986, Privacy Protection Act, Electronic Surveillance and Criminal Investigations, Communications Assistance for Law Enforcement Act, Other Questions Regarding Privacy: Peer-to-Peer or File sharing, Internet Service Provider Subscriber Records, Web sites, Cell phones.

UNIT 3: **12 lecture hours**

Traditional Problems in Computer Investigations, Forensic Duplication, Forensic Duplicates as Admissible Evidence, Forensic Duplication Tool Requirements, Creating a Forensic Duplicate/Qualified Forensic Duplicate of a Hard Drive, Phase after detection of an incident, Disk Structure and Data Storage, File Systems, Firmware Operating Instructions, Data Integrity, Developing Computer Forensic Science Capabilities, Traditional Problems Associated with Finding Digital Evidence, Pre-search Activities, On-scene Activities: Knock, Notice, and Document, Securing the Crime Scene, Determining the Need for Additional Assistance, Scene Processing, Locating Evidence, Seizure and Documentation of Evidence, Bagging and Tagging, Interviewing Witnesses, Collecting Network Based Evidence, Scene Departure and Transportation of Evidence to Lab, Forensic Analysis of File Systems, Hard Drives Evidence Handling, Challenges in evidence handling.

UNIT 4: **10 lecture hours**

Email Tracing Internet Fraud, Data Analysis Techniques, Investigating Live Systems (Windows & UNIX), Email Tracing Internet Fraud, Data Analysis Techniques, Investigating Live Systems (Windows & UNIX), Issues related to Data Privacy, Criminal Liability, Electronic Contracts & Digital Signatures, Misappropriation of information, Civil Rights, Evidence. Legal Developments, Security in

cyber laws case, Trademarks, Reverse Hijacking, Jurisdiction in Trademark Disputes, Copyright in the Digital Medium, Copyright and WIPO Treaties, Concept of Patent Right (30), Cryptography Laws, Ethical Issues – Cybercrime6.

Laboratory:

Explore the various tools for cyber forensic investigations. Experiments to show web vulnerabilities using DAMN Vulnerable Web App (DVWA). EnCase Forensics to make and restore image of the hard drive.

Text Books:

1. *Britz Marjie T, Computer Forensics and Cyber Crime: An Introduction (4th ed.), Pearson Education India, 2022. ISBN 978-0134847528.*
2. *Johansen Gerard, Digital Forensics and Incident Response: Incident response techniques and procedures to respond to modern cyber threats (2nd ed.), Packt Publishing Limited, 2020. ISBN 978- 1838649005.*

Reference Books :

1. Reddy Niranjan, *Practical Cyber Forensics* (1st ed.), Apress, 2019. ISBN 978-1484244605.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS245	Web Security	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To possess the skills to carry out independent analysis of modern malware samples.
CO2: To understand and analyses the Mobile application threat landscape.
CO3: To apply techniques to unpack, extract, decrypt, or bypass in future malware samples.

Course Contents:

UNIT 1: **08 lecture hours**
Web Basics: HTML, CSS, JS, URLs, DOM, Frames, HTTP, navigation, X-Domain communication, web security, Security elements, Implementation of safety assessment, understanding the dangers of an insecure communication channel, Network Attacks & HTTPS, HTTPS deployment, HTTPS impact on your application, Insights into the latest evolutions for HTTPS deployments, Limitations of HTTPS, Cookie Flaws and Server Misconfiguration.

UNIT 2: **08 lecture hours**
Security of Browser same origin policy, sandbox browser, malicious URL intercept, Rapid development of browser security, cross-site scripting attack, Advanced XSS attack, XSS defense, Cross-Site Request Forgery, Advanced CSRF defense, Clickjacking, HTML5 Securities, other security problems.

UNIT 3: **12 lecture hours**
Injection Attacks, SQL injection attacks, Database attacking techniques properly defending against SQL injection and other injection, File Upload Vulnerability, designing secure file upload features, Authentication and session management, Attacks on User Interfaces, Access control, Encryption algorithms and random numbers, Web framework security, Application-layer Denial-of-Service Attacks, PHP security, TCP Reset Attack.

UNIT 4: **14 lecture hours**
Security of Internet Business, Business logic security, How the account is stolen, Internet garbage phishing, User privacy protection ,Security development lifecycle, Security operations, Process of vulnerability patch, security monitoring, Practical ways to secure the authentication process, prevent authorization bypasses and harden session management mechanisms (10) security planning, business continuity planning, Handling incidents Risk Analysis, Dealing with disaster: privacy on the web, Privacy impacts of emerging technologies, Handling incidents, Risk Analysis, Dealing with disaster: privacy on the web, Privacy impacts of emerging technologies, Browser Design & Flaws.

Text Book:

1. *Hoffman Andrew, Web Application Security: Exploitation and Countermeasures for Modern Web Applications (1st ed.), O'Reilly Media, 2020. ISBN 978-1492053118.*

Reference Books :

1. McDonald Malcolm, *Web Security for Developers* (1st ed.), No Starch Press, 2020. ISBN 9781593279957.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSS246	Emerging Topics in Cyber Security	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1. Develop an understanding of the emerging threats, technologies, and strategies for defending and protecting an organization's cyber security.

CO2. Analyse and evaluate the effectiveness of current cyber security protocols and systems and develop best practices for mitigating and preventing new threats.

Course Contents:

UNIT 1: **42 lecture hours**

Cyber security is an ever-evolving field as new technologies and threats continue to emerge. In the past few years, there have been several emerging topics in cyber security that have become increasingly important, including cloud security, artificial intelligence, the Internet of Things (IoT), mobile security, blockchain technology, and quantum computing. Cloud security is the practice of protecting cloud-based systems, services, and data from malicious actors. Artificial intelligence is being used to detect and prevent cyber-attacks in real-time, as well as to automate manual security tasks. The Internet of Things (IoT) is a rapidly growing network of connected devices, all of which need to be secured. Mobile security is the practice of protecting mobile devices, including phones, tablets, and laptops, from threats. Blockchain technology is a distributed, secure ledger that is being used to store and share data and transactions, increasing security. Lastly, quantum computing is a new technology that has the potential to revolutionize computing power, with both positive and negative implications for cyber security. All of these technologies and topics must be addressed in order to ensure the security of systems, data, and users.

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Professional Elective

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSP301	Human Computer Interaction	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Understand the foundations of human-centered design, user needs, and interaction paradigms.
CO2: Apply usability principles, prototyping, and evaluation methods to design effective interfaces.
CO3: Analyze user behavior and system feedback to improve interactive systems using cognitive and perceptual models.

Course Contents:

UNIT 1:

HCI; Brief history – Vannevar Bush, Sketchpad, Xerox Star, Core goals – usability, user experience, Importance in modern software/systems, Perception and Cognition – Key cognitive principles: Attention, Perception – Gestalt principles, Memory – STM/LTM, Mental Models, Implications for design choices, Interaction Principles and Guidelines – Norman's principles: Affordance, Signifiers, Mapping, Feedback, Constraints, Shneiderman's 8 Golden Rules, Planning User Research – Choosing appropriate methods – qualitative vs. quantitative, Sampling and participant recruitment, Ethical considerations in research – consent, privacy, Interviews and Observation – Techniques for conducting user interviews – structured, semi-structured, Contextual inquiry and observation, Gathering rich, qualitative insights, Surveys and Analytics – Designing effective surveys, Using analytics data – e.g., web analytics to understand user behavior, Combining qualitative and quantitative data, Synthesizing Research: Personas and Scenarios – Creating evidence-based personas, Developing user scenarios and use cases, Defining user goals and tasks, Affinity diagramming, Task Analysis and Information Architecture – IA, Hierarchical Task Analysis – HTA, Goal Hierarchies, Structuring content/features, Sitemaps, Card Sorting.

UNIT 2:

Ideation Techniques and Sketching – Brainstorming methods, SCAMPER, Crazy 8s, Importance of sketching for exploring ideas quickly, Storyboarding user flows, Principles of visual design – Layout: grids, alignment, proximity, Typography, Color Theory, Importance of visual hierarchy and clarity in interfaces, Interaction Design Patterns – Common UI patterns for navigation: menus, tabs, forms, data display: tables, lists, feedback mechanisms, Selecting appropriate patterns, Microinteractions – search, filtering, onboarding, Designing engaging microinteractions, Importance of feedback and delight in interaction.

UNIT 3:

Prototyping: Why, What, and Fidelity Levels – Purpose of prototyping, Different fidelity levels – low-fidelity sketches/paper prototypes, mid-fidelity wireframes, high-fidelity interactive mockups, Choosing right fidelity, Low-Fidelity Prototyping and Wireframing – Techniques for paper prototyping, Creating digital wireframes, Focus on structure, layout, and flow, not visual details, Tools, High-Fidelity – Creating visually interactive prototypes, Industry-standard tools, Evaluation Frameworks and Heuristic Evaluation – formative vs. summative, Nielsen's 10 Usability Heuristics, Performing a heuristic evaluation.

UNIT 4:

Defining usability goals and metrics – effectiveness, efficiency, satisfaction, planning a test protocol, Recruiting participants, Setting up test environment – lab vs. remote, Moderating usability test sessions, Think-aloud protocol, Observing and recording data, Analyzing qualitative and quantitative findings, Reporting results, Cognitive Walkthroughs, Expert reviews, A/B testing for optimizing design choices.

UNIT 5:

POUR principles – Perceivable, Operable, Understandable, Robust, Web Content Accessibility Guidelines – WCAG and conformance levels, Privacy, Bias, and Dark Patterns – Ethical responsibilities in design, Recognizing and avoiding dark patterns, Designing for user privacy, Human-AI Interaction – HAI and Explainable AI (XAI), Unique challenges of designing interfaces for AI-powered systems, Principles of HAI – trust, transparency, control, Voice User Interfaces (VUI), Social Computing and CSCW, Ubiquitous Computing/IoT, Design Systems.

Text Book:

1. *Pancham Singh, Mrignainy Kansal, S.K. Kataria and Sons; "Human Computer Interface", 2024.*

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSP302	Blockchain Engineering	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate blockchain concepts and software applications that are used to develop the blockchain use cases.

CO2: To perform compilation, migrating, testing, and deploying the blockchain applications on the decentralized network.

CO3: To make use of building distributed ledger technologies for Blockchain applications and able to solve double spending problems in the digital payments using cryptocurrencies.

Course Contents:

UNIT 1: **14 lecture hours**

Blockchain platforms, distributed ledger technologies, distributed consensus algorithms, endless chains, Proof-of-elapsed time, Proof of Burn, Hyperledger, Frameworks, Fabric network, Transaction flow, Fabric– Membership, Identity management, Fabric components, Fabric deployment, Hyperledger Composer, Application Development, Composer – Network Administration.

UNIT 2: **14 lecture hours**

IPFS, Decentralized web, Privacy and encryption on IPFS, nodes, IPFS commands, IPFS vs HTTP, Location-based addressing, Content-based addressing, Distributed Hash Table (DHT), Merkle DAGs, IPNS, IPFS Gateway, IPFS Daemon, DNS Link, On-chin Transactions, Off-chain Transactions, Forking, Hard forks, Softworks, Double spending issues, Improving throughputs, Algorand, DAG-Chains, Hyper ledger Indy, Hyperledger Sawtooth.

UNIT 3: **14 lecture hours**

Decentralized Autonomous Organizations, DAO Membership, Problems with automated immutable systems, Challenges with the decentralized web, Defi (decentralized finance), Defi on Ethereum, Non-Fungible Tokens (NFTs), NFT use cases, Gas pricing, Ethereum development using Whisper, Swarm, and Raiden Network, State Channels, Case study, Costless Verification: Blockchain Technology, last mile problem, Verification cost reduction in blockchain, Bootstrapping network effects.

Text Books:

1. *Gaur, Nitin and et al, Hands-On Blockchain with Hyperledger: Building decentralized applications with Hyperledger Fabric and Composer (1st ed.), Packt Publishing Ltd, 2018. ISBN 9781788994521.*
2. *Pathak, Nishith and Anurag Bhandari, IoT, AI, and Blockchain for. NET: Building a Next Generation Application from the Ground Up (1st ed.), Apress, 2018. ISBN 9781484237083.*

Reference Books :

1. Bashir and Imran, *Mastering blockchain: "Distributed ledger technology, decentralization, and smart contracts explained"* (1st ed.), Packt Publishing Ltd, 2018. ISBN 9781787125445.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSP303	Quantum Computing	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate the differences between quantum and classical computation.
CO2: To understand the mathematical description of quantum states and basic quantum operations.
CO3: To become proficient with engineering requirements for quantum vs classical algorithm implementation.

Course Contents:

UNIT 1: Foundations of Quantum Computing
Quantum Computing Motivation, classical bits vs. quantum bits – qubits, Quantum States and Linear Algebra I – Hilbert spaces, state vectors, Dirac notation ($|\psi\rangle$), inner products, normalization, orthogonality, Quantum States and Linear Algebra – Basis states, superposition, global phase, tensor products for multi-qubit systems, Single-Qubit Gates and Measurements – Pauli gates (X, Y, Z), Hadamard (H), Phase (S, T) gates, unitary evolution, projective measurements, Born rule, Multi-Qubit Gates and Entanglement – CNOT, Controlled-Z, Toffoli gates, constructing entanglement – Bell states, concept of universal gate sets, Quantum Circuits and Qiskit – Quantum circuit model, visualizing circuits, brief intro to Qiskit structure – QuantumCircuit, backends.

UNIT 2: Noise and Information
Noise, Decoherence and Mixed States – Sources of noise: relaxation, dephasing, decoherence, limitations of state vectors, introduction to density matrices – ρ, Describing Noise: Quantum Operations – Mixed states vs. superpositions, partial trace, Kraus operators, quantum channels – depolarizing, amplitude damping.

UNIT 3: Algorithms
Query Model and Deutsch-Jozsa Algorithm – Black-box (oracle) model, Deutsch's problem, Deutsch-Jozsa algorithm demonstrating quantum parallelism, Bernstein-Vazirani and Simon's Algorithms – Bernstein-Vazirani algorithm, Simon's problem and algorithm, Quantum Teleportation and Superdense Coding – Using entanglement as a resource, protocols for teleportation and superdense coding.

UNIT 4: Search and QFT
Search and QFT – Grover's Search Algorithm, Unstructured search problem, Grover iteration: oracle and diffusion operator, geometric interpretation, Performance analysis – $O(\sqrt{N})$ complexity, optimality, potential applications, Quantum Fourier Transform (QFT) – Definition of QFT over □□, comparison to classical DFT, circuit implementation.

UNIT 5: Factoring and Phase
Quantum Phase Estimation (QPE) – Using QFT to estimate eigenvalues of unitary operators, circuit and analysis, QFT, Principles of Shor's Algorithm I: Reduction – Factoring problem, reduction to order finding, QPE for order finding, modular exponentiation circuit, classical post-processing, QPE.

UNIT 6: NISQ and Hardware

Quantum Complexity and BQP – P, NP, BQP, relationship between complexity classes, implications of Shor's algorithm, NISQ Era: Challenges and Error Mitigation – NISQ limitations, error mitigation techniques such as measurement correction and zero-noise extrapolation (ZNE), Density Matrix, Hybrid quantum-classical approach – VQE for ground state energy, QAOA for optimization, parameterized circuits, Superconducting and Trapped Ions – physical realization of qubits, principles, pros and cons of major platforms, Photonics and Other Approaches – photonic qubits, topological qubits, quantum annealing with D-Wave, Quantum Error Correction (QEC) – bit-flip and phase-flip codes, stabilizer codes introduction (e.g., Steane code), Application areas – chemistry, materials science, finance, machine learning, ethical considerations, future trends.

Text Books:

1. *Bernhardt, C. "Quantum Computing for Everyone". MIT Press, 2023.*
2. *Hidary, J. "Quantum Computing an Applied Approach". 2nd edn. Springer, 2022.*

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSP304	Augmented and Virtual Reality	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To establish and cultivate a broad and comprehensive understanding of this rapidly evolving and commercially viable field of Computer Science.
CO2: To prepare for participating in the production of highly integrative immersive applications, immersive social platforms, cross-disciplinary academic research projects, and leading developments in 3D user interfaces.
CO3: To create avatars: the virtual representation of other players, and agents: computer-controlled NPC characters.

Course Contents:

UNIT 1: Foundations of Extended Reality -XR
XR: Concepts, History, and Market Landscape, Human Perception for XR: Vision and Depth, Human Perception for XR: Audio, Vestibular, and Haptics, XR Hardware I: Displays and Optics, XR Hardware II: Tracking Sensors and Input Devices.

UNIT 2: XR Development Platforms and Graphics Pipeline
Real-Time Graphics Pipeline for XR, Rendering Techniques for XR: Stereo Rendering and Shading, Unity for XR Development, setting up Unity for VR: OpenXR and Scene Creation, Setting up Unity for AR: AR Foundation – ARKit/ARCore.

UNIT 3: Interaction Design and Implementation in XR
3D Interaction Principles in XR, Implementing VR Interaction: Locomotion, Implementing VR Interaction: Object Manipulation, Implementing AR Interaction: Touch, Gaze, and Gestures, UI/UX Design for XR.

UNIT 4: Core Technologies: Tracking and Environment Understanding
Tracking Fundamentals: Pose Estimation and Sensor Fusion, Inside-Out Tracking and SLAM Fundamentals, Visual SLAM and Visual-Inertial Odometry (VIO), Environment Understanding in AR: Plane and Feature Detection, Spatial Computing and Metaverse, WebXR, AI and Machine Learning in XR, Platform Ecosystems: Meta Quest, Apple VisionOS, and Others, Performance Optimization, Ethics, and Future Trends.

Text Books:

1. *Alan B Craig, William R Sherman and Jeffrey D Will, "Developing Virtual Reality Applications Foundations of Effective Design", Elsevier Publisher, 2022.*
2. *Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", USA, 2023.*

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSP305	Data Center Operations and Infrastructure	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Understand and apply design principles, physical infrastructure, and compute technologies in modern data centers.
CO2: Analyze and manage data center networking, virtualization, security, and operational strategies.
CO3: Evaluate sustainability, automation, and disaster recovery practices for resilient and efficient data center management.

Course Contents:

UNIT 1: Data Center Foundations and Design Principles

Modern Data Centers and IT Ecosystem – Enterprise, Colo, Cloud, Edge, role in digital infrastructure, Data Center Standards – Uptime, TIA-942 and Tier Classifications: Understanding Tiers I-IV, redundancy, maintainability, availability implications, and TIA-942 scope, Site Selection Criteria and Geographic Risk Assessment – Factors influencing location: power, network, hazards, cost, labor, risk mitigation, Data Center Design Principles – Modularity, Scalability, and Resilience: Architectural considerations, modular design approaches, planning for growth and fault tolerance, Total Cost of Ownership (TCO) Calculation and Key Factors – Understanding Capex vs. Opex, key cost components: infrastructure, power, cooling, maintenance, staffing, TCO analysis, Data Center Project Management and Lifecycle – Overview of planning, design, construction, commissioning, operations, and decommissioning phases.

UNIT 2: Physical Infrastructure: Power and Cooling

Electrical Power Systems: Distribution and Redundancy – Utility feeds, switchgear, transformers, power distribution paths, N+1/2N redundancy concepts, Uninterruptible Power Supply (UPS) Systems and Backup Generators – Types of UPS: standby, line-interactive, online, battery technologies, generator integration, ATS, Power Quality, Monitoring and Management – Power issues: sags, surges, power quality monitoring, intelligent PDUs, branch circuit monitoring, Environmental Guidelines – ASHRAE: Heat load calculation (BTU/hr, Watts), psychrometrics, ASHRAE temperature, humidity, dew point recommendations, Air Cooling Strategies and Airflow Management – CRAC/CRAH units, raised floors, hot/cold aisle containment, economization (free cooling), Direct-to-Chip and Immersion Cooling – Principles, types: single/two-phase DTC, single/two-phase immersion, coolants, use cases (high-density/AI), implementation considerations.

UNIT 3: Compute, Storage, and Virtualization Infrastructure

1. Server Hardware Evolution and High-Density Computing – including OCP: server form factors, CPU/GPU impact on density, OCP designs and benefits, Data Center Storage Architectures – SAN, NAS, Object and Hyperconverged Infrastructure (HCI): comparing block, file, object storage; DAS vs. SAN vs. NAS, Storage Networking and Performance Considerations – Fibre Channel, iSCSI, NVMe-oF protocols; performance metrics: IOPS, latency, throughput; storage tiering, Server Virtualization at Scale – Hypervisors and management: concepts of VMs, hypervisors (VMware, Hyper-V, KVM), resource pooling, live migration (vMotion), challenges at scale, Containerization – Docker and orchestration with Kubernetes in data centers: container concepts, Docker basics, Kubernetes architecture, containerized applications within data centers, Centralized management consoles, resource scheduling (DRS), performance monitoring, capacity management for virtual environments.

UNIT 4: Data Center Networking and Connectivity

Data Center Network Topologies: Spine-Leaf Architecture – evolution from traditional tiered designs, Spine-Leaf principles and benefits including scalability, latency, bandwidth, High-Speed Switching and Routing Technologies for Data Center Fabrics – Ethernet speeds (10/40/100/400 GbE), large-scale switch capabilities, routing protocols in DC such as BGP, Software-Defined Networking (SDN) Concepts and Architectures – control/data plane separation, SDN controllers, northbound/southbound APIs, overlay vs. underlay networks, SDN Implementation and Management in Data Centers – use cases including automation, security, traffic engineering, common platforms, operational considerations, Data Center Interconnect (DCI) – optical transport (WDM), high-speed Ethernet, MPLS, SD-WAN for connecting DCs, supporting disaster recovery, hybrid cloud, data replication, Structured Cabling and Physical Network Infrastructure – copper and fiber media types, standards (Cat6a, OM4/OS2), cable management, patch panels, physical pathways, Data Center Monitoring – key metrics (system, network, environmental), monitoring tools (Nagios, Zabbix, Prometheus, Grafana), alerting strategies.

UNIT 5: Data Center Operations and Management

Physical Security Design and Technologies – layered security approach, perimeter security, access control methods such as mantraps, biometrics, surveillance, environmental security, Network Security Paradigms – Zero Trust principles, implementing microsegmentation (network/host-based) to reduce attack surface and lateral movement, Compliance Frameworks – SOC 2, ISO 27001, and governance: overview of key standards, relevance to data centers, importance of policies, procedures, and audits, Sustainability Metrics – PUE, WUE, CUE and green data center practices: defining and calculating metrics, strategies for improving efficiency including cooling, power, hardware, renewable energy options, heat reuse, Hybrid Cloud Integration and Edge Computing Strategies – managing hybrid environments, cloud connectivity (DCI), role of edge computing and its impact on data center design, Disaster Recovery and Business Continuity Planning (DR/BCP) – strategy development, RTO/RPO technical solutions including backup, replication, site redundancy, and testing procedures.

UNIT 6: Security, Sustainability

Data Center Infrastructure Management (DCIM) Systems – core functions including asset, capacity, power, thermal, workflow management, benefits, integration points, major vendors and platforms, Declarative vs. Imperative approaches – benefits such as automation, consistency, versioning, and use cases in data centers, Terraform and Ansible for Data Centers – Terraform for provisioning and Ansible for configuration management, syntax and workflows for managing data center resources, AIOps for Data Centers – applying AI/ML techniques for anomaly detection, predictive analytics, root cause analysis, and benefits for proactive operations, Incident Management and Root Cause Analysis – ITIL/SRE approaches, incident lifecycle, techniques for RCA, importance of blameless post-mortems for continuous improvement.

Text Books:

1. *Hwaiyu Geng, "Data Center Handbook", 3rd Edition, 2023.*
2. *Art Carle, "Data Center Builder's Bible", 2023.*

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSP306	DevOps and Full Stack	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Design and develop full-stack web applications using modern backend and frontend frameworks.
CO2: Implement CI/CD pipelines, containerization, and cloud infrastructure practices for efficient deployment.
CO3: Apply Infrastructure as Code (IaC), monitoring, and collaboration strategies for scalable software delivery.

Course Contents

UNIT 1: Foundations
Course Overview and Modern Software Lifecycle, Advanced Git and Collaboration Strategies

UNIT 2: Backend Development
Backend Frameworks and Architecture -Node.js/Express Focus, API Design and Development - RESTful APIs

UNIT 3: Data Persistence and Front-End Development
Database Integration: SQL and NoSQL, Modern Frontend Frameworks -React Focus

UNIT 4: CI/CD -Continuous Integration / Continuous Deployment
CI/CD Principles and Pipelines, CI/CD Tooling -Jenkins/GitHub Actions Overview

UNIT 5: Containerization
Containerization with Docker, Container Orchestration Fundamentals -Kubernetes Intro

UNIT 6: Cloud and Infrastructure Management
Infrastructure as Code -IaC Concepts -Terraform Overview, Monitoring, Logging and Course Wrap-up

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSP307	Game Mechanics, Design and Development	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate different types of bodies and their dynamics, used in-game programming.
CO2: To implement the collision detection and their resolution techniques.
CO3: Demonstrate production, teamwork, and pitching skills essential for real-world game development and portfolio building.

Course Contents

UNIT 1: Foundational Concepts
Defining Games and Play, MDA Framework, Game History, Genres, and Context, Core Loops and Player Experience Goals, Prototyping, Playtesting.

UNIT 2: Core Mechanics and Systems Design
Player Input, Control, and Movement, Action, Combat, and Interaction Mechanics, Puzzle Mechanics and Challenge Design, System Design: Economies, Progression, Balancing, Intermediate Scripting in Unity, User Interface (UI) Fundamentals.

UNIT 3: World, Narrative, and Experience Design
Level Design Principles, Narrative Design Fundamentals, User Experience (UX) Design, Audio Design Principles, Visual Design and Art Pipeline Overview, Advanced Scripting Concepts.

UNIT 4: Production, Industry Context, and Portfolio
Game Production Pipeline and Methodologies, Team Dynamics and Project Management, Game Feel and Polish, Monetization, Marketing, and Business, Pitching and Presenting Games, Portfolio Development and Career Paths.

Text Books:

1. Schell Jesse, *The Art of Game Design: A Book of Lenses,* (3rd ed.), A K Peters/CRC Press, 2019. ISBN 1138632058.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSP308	Java Programming	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To examine different programming structures in a platform independent language such as wrapper classes, collections, exceptions, and multithreading.
CO2: To explain the concepts of object-oriented programming like encapsulation, abstraction, inheritance and polymorphism.
CO3: Make use of GUI and database-based programming to develop Applications for real life problems.

Course Contents

UNIT 1: Control Flow and Program Strcuture

Setting Up Your Java Development Environment, Variables, Data Types, and Operators, Expressions and Input/Output in Java, Conditional Statements: Making Decisions in Java, Looping Constructs, Methods and Functions in Java: Modularizing Code, Scope and Lifetime of Variables.

UNIT 2: Object-Oriented Programming Fundamentals

Object-Oriented Concepts: Classes and Objects, Constructors and Object Initialization, Access Modifiers and Encapsulation in Detail, Inheritance: Extending Functionality, Method Overriding in Java, super Keyword in Java, Polymorphism: Many Forms in Java, Abstract Classes and Methods in Java, Interfaces in Java: Defining Contracts, Implementing Multiple Interfaces in Java, Differences Between Abstract Classes and Interfaces.

UNIT 3: Arrays and Strings in Java

Arrays - Array Manipulation and Common Operations, Working with Text, StringBuilder and StringBuffer: Mutable Strings

UNIT 4: Exception Handling and Collections Framework

Exceptions: Throwing and Catching Exceptions, Built-in Exception Classes and Creating Custom Exceptions, finally Block, Collections Framework: Organizing Data, Lists as Ordered Collections – ArrayList and LinkedList, Sets as Collections of Unique Elements – HashSet and TreeSet, Maps as Key-Value Pairs – HashMap and TreeMap, Generics: Type Safety and Reusability, Generic Classes and Methods in Detail, Concise Anonymous Functions, Functional Interfaces, and Using Lambda Expressions.

UNIT 5: I/O Operations and Multithreading

Input/Output Streams in Java, reading from and Writing to Files – Text and Binary Files, Working with Buffered Streams for Efficiency, Multithreading: Concurrent Execution, Threads in Java: Extending Thread and Implementing Runnable, Thread Synchronization – Avoiding Race Conditions, Thread Communication, Networking: Sockets, Databases, and JDBC.

Text Books :

1. Schildt, Herbert. *Java: the complete reference*. 10th ed. McGraw-Hill Education Group, 2014. ISBN 978-93392120.

2. Bloch, Joshua. *Effective java (the java series)*. 1st ed. O'Reilly Media, Inc., 2017. ISBN 978-0134686097.

Reference Books :

1. Anuradha A. Puntambekar, *ObjectOriented Programming*. 1st ed. UNICORN Publishing Group, 2020. ISBN 9789333223819.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSP309	Security Ethics and Regulations in AI	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Analyze the evolving threat landscape and vulnerabilities across the AI system lifecycle, including LLMs and adversarial attacks.
CO2: Apply MLSecOps practices to develop and deploy secure, robust, and resilient AI models.
CO3: Evaluate ethical, legal, and governance frameworks to ensure AI transparency, fairness, accountability, and compliance.

Course Contents

UNIT 1: AI Threat Landscape and Vulnerabilities

AI Triad: Security, Ethics, and Regulation, AI System Lifecycle and Associated Risks, Privacy, Fairness, Accountability, Transparency (FAT*) in AI Context, Evolving Threat Landscape: Adversarial AI, Evasion: Fooling Deployed Models, Poisoning Attacks: Corrupting Learning Process, Inference and Extraction Attacks: Stealing Secrets, LLM and Transformer Vulnerabilities: Prompt Injection and Jailbreaking, LLM and RAG Vulnerabilities: Data Poisoning, Supply Chain and Vector DB Issues, Frameworks for Understanding AI Threats: MITRE ATLAS.

UNIT 2: Securing AI Systems and ML Lifecycle -MLSecOps

MLSecOps: Principles and Practices, Secure Data Management and Provenance, Secure Model Development and Training, Secure Deployment and Monitoring.

UNIT 3: Ethical Dimensions of AI

Ethical Frameworks and Principles, Deep Dive into AI Bias: Sources, Detection and Mitigation, Transparency vs. Explainability: Beyond Black Box, Human Agency, Oversight and Accountability Mechanisms, Ethical Challenges in Generative AI and Autonomous Systems, Societal Impacts: Inequality, Job Displacement, Environment.

UNIT 4: AI Governance and Compliance

Global Regulations: EU AI Act, US and NIST AI Risk Management Framework (RMF), International Standards: ISO/IEC AI Standards - 42001, 23894, India's Regulatory Approach: DPDP Act 2023 and AI Governance, India's AI Governance Initiatives: MeitY, NITI Aayog and IndiaAI Mission, Sector-Specific Regulations and Cross-Border Challenges, AI Governance Frameworks, AI Auditing: Principles and Practices, Compliance Strategies and Tools, Future Trends in Trustworthy AI.

Text Books:

1. *Sadeghi, A.-R., and Shokri, R. "Security and Privacy in AI systems". Springer,2024.*
2. *Scherer, M. U. "The Law of Artificial Intelligence". Edward Elgar Publishing,2023.*

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSP310	Game Engine and Architecture	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To explain concepts of underlying game engines. Solve practical 3D game problems.

CO2: To Implement Game control systems for multiplayer games using Human Interface Devices and analyse the basic features of Physics for Games; Illustrate the collision detection systems used in games.

Course Contents:

UNIT 1: **10 lecture hours**

Game Engine, Engine Differences Across Genres, Runtime engine architecture: Base layer, Memory, layer, Utility, UNIT, Management, Gameplay, Build layers, Asset Pipeline, Pre-rendering pipeline, Full 3D pipeline, Game profiler, Tools for optimization of games, Types of profilers, Version control in game development, Best Practices in version control, Issues and solutions, UNITy engine and features, Unreal engine and features, Amazon Lumberyard and features, cryEngine for VR and features

UNIT 2: **10 lecture hours**

Engine Levels, Game Engine VR Modes actors, Landscape, Water rendering, Lightening and Environment, Capsule shadow, light mobility, and types of lights, Volumetric clouds, Fog effects, Level streaming, Hierarchal level of details, Blueprints, Variables, functions, and flow control, Timelines and blueprint classes, Render To Texture Blueprint Toolset, Occlusion Culling, Render targets, Real time raytracing, Frame Rendering tool, Programming and scripting, Actor Communication, Blueprint visual scripting, Gameplay Architecture, Gameplay classes and functions, Interfaces, Graphics Programming, Shader development, Threaded rendering, Mesh drawing pipeline, Slate UI Framework.

UNIT 3: **10 lecture hours**

Human Interface Devices, Types of HID for games, Interfacing with HID, Devices in practice, features of popular devices, Gameplay Framework, Pawn, Controller, Camera, AI Entities in gaming, Behavior trees, navigation system, Environment query system, Physics in gaming, UMG UI Designer, Networking and multiplayer, Animation Characters and Objects, Animation rigging toolset, Skeletal Mesh Animation System, Sound in gaming, Ambient Zones, Sound classes, Audio Engine and mixer, Sound Attenuation, Sound cue.

UNIT 4: **12 lecture hours**

Importing and integration media objects, Asset management, Asset Build tool, Automation tool, Testing and Optimization, Performance and profiling, Animation System Architecture, Animation Blending, Animation Pipeline, Skinning and Matrix Palette Generation, Skeletons 496x, Animation controller Collision and Rigid Body Dynamics, Collision/Physics Middleware, The Collision Detection System, Rigid Body Dynamics, and Advance physics features.

Text Book:

1. *Jason Gregory, Jeff Lander and Matt Whiting, Game Engine_Architecture (3rd ed.), A K Peters/CRC Press, 2018. ISBN 978-1138035454.*

Reference Books :

1. Heather Maxwell Chandler, *Game Production Handbook* (3rd ed.), Jones & Bartlett, 2013. ISBN 978- 1449688097.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSP311	Machine Learning with Quantum Computing	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To explore and understand whether quantum computers can speed up the time it takes to train or evaluate a machine learning model.
CO2: To examine the interplay of ideas from quantum computing and machine learning.
CO3: To develop new quantum algorithms and explore the properties of quantum systems.

Course Contents:

UNIT 1: **12 lecture hours**

Course structure/handout assessment mechanism, why quantum machine learning? Tensor and Tensor Network, Hadamard Transformation, Quantum lambda calculus, Quantum Encode and Decode, Arbitrary StateGenerator, Quantum Density Operator or Density Matrix, Quantum Probability Theory, Quantum Stochastic Process, Quantum Mean, Variance and Envariance, Quantum Way of Linear Regression, Quadratic Unconstrained Binary Optimization, Quantum Topological Data Analysis, Quantum Bayesian Hypothesis, Haar Transform, Quantum Ridgelet Transform, Variational Quantum Eigen-solver.

UNIT 2: **10 lecture hours**

Quantum Perceptron's, Quorn's, Quantum Auto Encoder, Quantum kernel estimation, Quantum Feature Map, Comparisons between QKE and classical kernels, Quantum Classifier, Variational Models, Quantum Approximate Optimization Algorithm, Quadratic Unconstrained Binary Optimization (QUBO), MaxCut problem.

UNIT 3: **12 lecture hours**

Quantum Annealing, Photonic Implementation of Quantum Neural Network, Quantum Feed Forward Neural Network, Quantum Boltzman Neural Network, Quantum Neural Net Weight Storage, Quantum Upside Down Neural Net, Quantum Hamiltonian Neural Net, Quantum artificial neural network, Quantum Perceptron Network, Quantum approaches to CNNs, Quantum convolutional networks, Dissipative quantum neural networks, Barren plateaus in QNNs, Barren plateaus in deep QNNs, Noise-induced Barren plateaus, Superposition based Architectural Learning Algorithm, Quantum Hamiltonian Learning, Compressed Quantum Hamiltonian Learning, Quantum Classification using Principle Component Analysis, Quantum state classification with Bayesian methods, Quantum K-Nearest Neighbour, Quantum K- Means, Quantum Fuzzy C-Means.

UNIT 4: **08 lecture hours**

Quantum Support Vector Machine, Quantum Ant Colony Optimization, Quantum-behaved Particle Swarm Optimization, Quantum Inspired Evolutionary Algorithm, Quantum Genetic Algorithm, Quantum Hidden Markov Models, Quantum Annealing Expectation-Maximization, Quantum Estimation Theory, Quantum Statistical Decision Theory, Quantum Hypothesis Testing, Quantum Chi-squared and Goodness of Fit Testing.

Text Books:

1. *Siddhartha Bhattacharyya, Sourav De, Indrajit Pan, Ashish Mani, Elizabeth Behrman and Susanta Chakraborti, Quantum Machine Learning (1st ed.), De Gruyter, 2020. ISBN 9783110670704.*

2. *Eric R. Johnston, Nic Harrigan and Mercedes Gimeno-Segovia, Programming Quantum Computers (1st ed), O'Reilly, 2019. ISBN 9781492039659.*

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSP312	Generative AI	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Understand and apply core architectures of generative models including VAEs, GANs, Transformers, and Diffusion Models.
CO2: Develop and fine-tune generative models for text, image, audio, and video synthesis across diverse applications.
CO3: Evaluate generative outputs using quantitative and qualitative metrics while addressing ethical and responsible AI practices.

Course Contents:

UNIT 1: Foundations of Generative AI

Generative AI: Concepts and Applications, Review of Deep Learning Foundations for Generative Models, Variational Autoencoders (VAEs): Architecture and Learning, VAEs: Latent Space Exploration and Generation.

UNIT 2: Generative Adversarial Networks

Generative Adversarial Networks (GANs): Adversarial Training Process, GANs: Architectures and Stability Challenges, Advanced GAN Techniques: Conditional GANs and Style Transfer.

UNIT 3: Sequence Generation and Transformers

Autoregressive Models for Sequence Generation, Autoregressive Models in Natural Language Processing, Transformer Networks for Generative Tasks, Large Language Models (LLMs): Architecture and Pre-training, LLMs: Fine-tuning and Instruction Following.

UNIT 4: Diffusion Models and Multimodal Generation

Diffusion Models: Forward and Reverse Processes, Diffusion Models for Image Synthesis, Advanced Diffusion Techniques: Conditional Generation and Latent Diffusion, Generative Models for Audio Synthesis and Music Generation, Generative Models for Video Synthesis and Animation.

UNIT 5: Evaluation, Applications, and Ethics of Generative AI

Evaluation Metrics for Generative Models: Quantitative Approaches, Evaluation Metrics for Generative Models: Qualitative and Human Evaluation, Applications of Generative AI in Creative Arts and Design, Applications of Generative AI in Science and Engineering, MLOps for Generative AI: Deployment and Monitoring, Ethical Considerations in Generative AI: Bias and Fairness, Responsible AI Development and Future Trends in Generative AI.

Text Books:

1. David Foster, "Generative Deep Learning",2nd Edition, 2023.
2. Karthikeyan Sabesan, "Generative AI for Everyone", 2025.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSP313	Drone Remote Sensing	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate the fundamentals of UAV Remote Sensing.
CO2: To learn techniques and deployment scenarios of UAVs, alongside the challenges and potential solutions to data acquisition, mapping, and processing.
CO3: To construct multirotor, agricultural precision remote sensing UAV from scratch using various sensors, cameras, and flight controllers.

Course Contents:

UNIT 1: **12 lecture hours**

Sensing and Control; Application Scenarios and Challenges; Radio Controlled Vehicles to UAVs; Sensors: Sensor Types and Applications; Regulations and Guidelines; Attitude Estimation: Sensors, Complimentary Filters, Kalman Filters; UAV Imagery: Accuracy Requirements, Operational Restrictions.

UNIT 2: **10 lecture hours**

Image Sensors; Image Sensor Selection; Computing Image; Imagery Collection; UAV Remote Sensing; Coverage Control; Georeferencing; Feature-Based Stitching; Position and Attitude BasedStitching; Consensus-Based Formation Control; Consensus Algorithms; Profile Measurement and Estimation; Wind Profile Measurement.

UNIT 3: **10 lecture hours**

Mission Planning: Surveyed Geography, Alien Terrain; GPS Data Collection; Measurement; Mapping; UAV Path Planning; Path Refinement; Multi-UAV Path; Obstacle Avoidance; Focus ofExpansion; Time to Collision; Semi-Autonomous Control; Radio Control; Automatic Control; Control Switching: Radio and Automatic.

UNIT 4: **10 lecture hours**

Drone Sensing and Imagery: Riverine, Aquatic, Agriculture, Vegetation and Forest Ecosystem, Oiland Gas, Surveillance, Search and Rescue; UAS Ground Control; Human Machine Interface; Computer Telemetry; UAV Launch System; UAV Recovery System.

Text Book:

1. *Serge A. Wich and Lian Pin Koh, Conservation Drones: Mappingand Monitoring Biodiversity (1st ed.), OUP Oxford, 2018. ISBN 0198787618.*

Reference Books:

1. Amy Frazier and Kunwar Singh, *Fundamentals of Capturing and Processing Drone Imagery and Data* (1st ed.), CRC.
2. David R. Green, Billy J. Gregory and Alexander Karachok, *Unmanned Aerial Remote Sensing* (1st ed.), CRC Press, 2020. ISBN 1482246074..

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSP314	Digital Bots Development	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (Cos)

On completion of this course, the students will be able to:

CO1: To understand the underlying logic/structure related to robotic process automation.
CO2: To develop digital bots to automate the processes.
CO3: To implement the transactions in business processes using robotic process automation.

Course Contents:

UNIT 1: **10 lecture hours**

Course structure/handout Assessment mechanism, Automation 360, Using Discovery Bot for Process Documentation, Creating Discovery Bot Users, Use Case: Discovering the Customer ID Validation, Create Process, Record Process, Review Recordings and Create Opportunities, Convert Opportunity to Bot Prototype, Resilient Bots, Run time challenges, HandlingUnpredictable Exceptions, Handling Predictable Exceptions, Modularity and reusability are the key to scalability, Creating scalable Bots, Universal recorder Excel automation.

UNIT 2: **12 lecture hours**

Integration of Java Scripts with Automation Anywhere, Invoking of Java Script using automation 360, Integration of VB Script in Automation Anywhere, Code execution of VB Script using Automation Anywhere, Integration of Python script with Automation Anywhere, Running Python Script in Automation Anywhere. Automation anywhere Robotic Interface with back office business process use case, creating form Creation of the Bots, Creation of Process, Automation anywhere Robotic Interface with front office business process use case, Creating form, Creationof the Bots, Creation of Process, Automation anywhere Robotic Interface process creation, Automation anywhere Robotic Interface task creation.

UNIT 3: **10 lecture hours**

AAE Client in RPA Development, Smart recorder, Screen recorder, Web recorder, editing a recorded Bot Workbench components, Leveraging workbench commands, Integrating RPA with Cognitive Solutions Understanding IQ Bot as a Cognitive solution, Utilizing the IQ Bot Portal, Following the IQ Bot Workflow Creating an Instance and Triggering Document analysis, ReadingInstance Details, Editing an Instance.

UNIT 4: **10 lecture hours**

Understanding RPA Analytics, Understanding Operational Analytics, Understanding Business Analytics Roles Generating Business Analytics Understanding the CoE Dashboard, Customizing and Comparing CoE Dashboards, publishing a CoE Dashboard, Using the RPA Mobile App, Recording of tassk with AISense recorder, Edit a task recorded using AISense, Advanced Topics in AA, Use of variable anchor, Enable debug logs for AISense recorder.

Text Books:

1. *Mullakara, Nandan, and Arun KumarAsokan, Robotic process automationprojects: Build real-world RPA solutions using UiPath and AutomationAnywhere (1st ed.), Packt Publishing Ltd, 2020. ISBN 9781839217357.*

2. *Husan Mahey, Robotic Process Automation with Automation Anywhere: Techniques to fuel business productivity and intelligent automation using RPA (1st ed.), Packt Publishing Ltd, 2021. ISBN missing.*

Reference Books:

1. Husan Mahey, *Robotic Process Automation with Automation Anywhere* (1st ed.), Packt Publishing Ltd, 2021. ISBN 9781839215650.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSP315	VR and 360 Video Production	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To learn how to create a VR use flow.
CO2: To use Tools and Gaming Platforms to build VR experiences and 360 Video production.
CO3: Make next steps to start building a VR experience using latest tools and technologies.

Course Contents:

UNIT 1: **10 lecture hours**

Intro to design: Understand basic VR design principles such as iteration, user testing, and documentation, Design foundations, ergonomics: Create a VR User Persona, design an ergonomicVR experience, VRText, VR Testing Scene.

UNIT 2: **12 lecture hours**

Introduction to Immersive Media: principles of immersive 360 media such as spherical projection by critically reviewing professional 360 content, workflow of creating 360 Video, Metadata to 360video and publishing, Analyze a variety of existing 360 video content, Analyze footage for the various techniques, tips, and tricks, Scripting and Planning: Create a script for 360 content, Plan a 360 shoot, Edit scripts to match equipment and budget, 360 cameras: Exploration of existing 360 cameras, Differentiate between monoscopic and stereoscopic capture, different equipment and techniques used for audio capture, lighting techniques for 360 video.

UNIT 3: **12 lecture hours**

Stitching: Stitch 360 video, Blend, weight, synchronize, and stabilize footage, Editing Basics: Edit footage, create transitions in 360 video, Advanced Editing: Color correct 360 footage, Add pointsof interest, Advanced Stitching: edit and refine stitching using control points and masks, Blending.

UNIT 4: **8 lecture hours**

Spatial Audio: Cut spatialized audio, Place sound in 3D space, Interactivity with Gaming platform: Create an interactive 360 experience using Gaming platform's video player, player controls and branching storylines using a custom 360 video player.

Laboratory:

The experiments to create 360 videos with metadata, capture and use 3D audio to 360 videos. Adding interaction control, adding transition in 360 videos, 360 video testing and performance Evaluation.

Text Book:

1. *Jesse Glover and Jonathan Linowes, Complete Virtual Reality and Augmented Reality Development with Unity (1st ed.), Packt Publishing Limited, 2019. ISBN 9781838644865.*

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSP316	Product Design Architecture and Delivery	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate product design architecture and communication in designing.
CO2: To examine all mandatory models by developing the prototype.
CO3: To make use of development methods that can be exploited in the delivery of the product.

Course Contents:

UNIT 1: **10 lecture hours**

What Is Product Architecture? Types of Modularity, Implications of the Architecture, Product Change, Product Variety, Component Standardization, Product Performance, Manufacturability, Product Development Management, Establishing the Architecture, Create a Schematic of the Product, Cluster the Elements of the Schematic, Create a Rough Geometric Layout, Identify the Fundamental and Incidental, Platform Planning, Differentiation Plan, Commonality Plan, Defining Secondary Systems, Creating Detailed Interface Specifications, Industrial Design, Assessing the Need for Industrial Design ,Expenditures for Industrial Design, Industrial Design to a Product, User Experience Needs ,Aesthetic Needs, The Impact of Industrial Design, Is Industrial Design Worth the Investment? How Does Industrial Design Establish a Corporate Identity? The Industrial Design Process, Investigation of Customer Needs, Conceptualization, Preliminary Refinement, Further Refinement and Final Concept Selection, Control Drawings or Models,Coordination with Engineering, Manufacturing and External Vendors, Management of the Industrial Design Process, Timing of Industrial Design Involvement, Assessing the Quality of Industrial Design Usability, Emotional Appeal, Ability to Maintain and Repair the Product, Appropriate Use of Resources, Product Differentiation.

UNIT 2: **10 lecture hours**

Design for Environment, Environmental Impacts, Herman Miller's Journey toward Design for Environment, The Design for Environment Process, Design for Environment Guidelines, Design for Manufacturing and Supply Chain, Requires a Cross-Functional, Overview of the DFM Method, Strategic Sourcing Decisions, Estimate the Manufacturing Costs, Cost of Goods, Fixed Costs versus Variable Costs, The Bill of Materials, Estimating the Costs of Standard Components,Estimating the Costs of Custom Components, Estimating the Costs of Assembly, Estimating the Overhead Costs, Reduce the Costs of Components, Understand the Process Constraints and Cost Drivers, Redesign Components to Eliminate Processing Steps, Choose the Appropriate Economic Scale for the Part Process, Standardize Components, Adhere to the "Black Box" Component, Procurement, Reduce the Costs of Assembly and Integrate Parts, Maximize Ease of Assembly, Consider Customer Assembly, Reduce the Costs of Supporting, Production, Minimize Systemic Complexity, Error Proofing, Reduce the Costs of Logistics, guidelines for minimizing the volume, Materials Costs, Component Manufacturing Costs, Assembly Costs, Cost Structures, Impact of DFM Decisions: The Impact of DFM on Development Time, The Impact of DFM on Development Cost, The Impact of DFM on Product Quality, The Impact of DFM on the Larger Enterprise.

UNIT 3: **14 lecture hours**

Prototyping, Understanding Prototypes, Types of Prototypes, What Are Prototypes Used For? Principles of Prototyping, Analytical Prototypes, Physical Prototypes, Prototyping Technologies, 3D

Printing, Planning for Prototypes, Define the Purpose of the Prototype, Establish the Level of, Approximation of the Prototype, Outline an Experimental Plan, Create a Schedule for Procurement, Construction, and Testing, Planning Milestone Prototypes, Robust Design, Designof Experiments , Robust Design Process, Identify Control Factors, Noise Factors, and Performance Metrics, Formulate an Objective Function, Develop the Experimental Plan, Experimental Designs, Testing Noise Factors, Run the Experiment, Conduct the Analysis, Computing the Objective Function, Computing Factor Effects by Analysis of Means, Select and Confirm Factor Setpoints, Reflect and Repeat Caveats, Patents and Intellectual Property, What Is Intellectual Property? Overview of Patents, Utility Patents, Preparing a Disclosure, formulate a Strategy and Plan, Timing of Patent Applications, Type of Application, Scope of Application, Study Prior Inventions, Outline Claims, Write the Description of the Invention Figures, Writing the Detailed Description, Defensive Disclosure, Refine Claims, Writing the Claims, Guidelinesfor Crafting Claims, Pursue Application, Reflect on the Results and the Process, Advice to Individual Inventors, Service Design Product-Service Systems, In What Ways Are Services and Products Different? Service Design Process, The Service, Development at Zipcar, Service ProcessFlow Diagram, Subsequent Refinement, Downstream Development Activities in Services, prototyping a Service, Growing Services, Continuous Improvement.

UNIT 4: **8 lecture hours**

Product Development Economics, Elements of Economic Analysis, Quantitative Analysis, Qualitative Analysis, Economic Analysis Process, Build a Base-Case Financial Model, Estimate the Timing and Magnitude of Future Cash Inflows and Outflows, Perform Sensitivity Analysis, Development Cost Example, Development Time Example, Understanding Uncertainties, Use Sensitivity Analysis to Understand, Trade-Offs, Potential Interactions, Trade-Off Rules, Limitations of Quantitative Analysis Projects Interact with the Firm, the Market, and the Macro Environment, Carrying Out Qualitative Analysis, Time Value of Money and the Net Present Value Technique, Modeling Uncertain Cash Flows Using Net, Present Value Analysis, Project Management, The Design Structure Matrix, Gantt Charts PERT Charts, Critical Path, Baseline Project Planning, Contract Book, Project Task List, Team Staffing and Organization, Project Schedule, Project Budget, Project Risk Plan, Modifying the Baseline Plan, Accelerating Projects, Project Execution, Coordination Mechanisms, Assessing Project Status Corrective Actions, Postmortem Project Evaluation.

Laboratory:

In the studio work, students perform the architectural design of the product and deliver the product design prototype.

Text Book:

1. *Karl T. Ulrich, Steven D. Eppinger and Maria C. Yang, Product Design and Development (7th ed.), McGraw Hill, 2020. ISBN 9390113237.*

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSP317	Advance Swift Programming	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course-Outcomes (COs):

On completion of this course, the students will be able to:

CO1: To articulate features of Object-Oriented Programming concepts in Swift.

CO2: To implement object-oriented features of Swift using Playgrounds.

CO3: To solve real-world problems using Swift concepts.

Course Contents:

UNIT 1: **10 lecture hours**

Closure Expressions, Inferring Type from Context, Implicit Returns from Single- Expression Closures, Shorthand Argument Names, Operator Methods, Trailing Closures, Capturing Values, Escaping Closures. Enumeration: Enumeration, Enumeration with Switch Statement, Iterating Enumeration Cases, Associated Values, Raw Values, Recursive Enumerations.

UNIT 2: **10 lecture hours**

Definition Syntax, Structure and Class Instances, Accessing Properties, Memberwise JInitializers for Structure Types, Value types or Reference Types. Properties, Stored Properties, Lazy Stored Properties, Computed Properties, Property Observers. Global and Local Variables, Type Properties, Type Property Syntax, Querying and Setting Type Properties.

UNIT 3: **10 lecture hours**

Methods, Instance Methods, self-Property, Mutating Method, Type Methods Inheritance: Base class, types of Inheritance, Subclassing, overriding: Accessing Superclass Methods, Properties, and Subscripts, Overriding Methods, Overriding Properties, Overriding Property Getters and Setters, Preventing Overrides.

UNIT 4: **12 lecture hours**

Initializers, Default Property Values, Customizing Initialization, Initialization Parameters, Parameter Names and Argument Labels, Initializer Parameters Without Argument Labels, Optional Property Types, Default Initializers, Initializer Delegation for Value Types, Class Inheritance and Initialization, Initializer Inheritance and Overriding, Automatic Initializer Inheritance, Failable Initializers, Failable Initializers for Enumerations, Overriding a Failable Initializer.

Text Books:

1. *Matthew Mathias, John Gallagher, Swift Programming: The Big Nerd Ranch Guide edition, 2015.*
2. *Matt Neuberg, iOS 12 Programming Fundamentals with Swift, OReilly; 5th edition. App Development with Swift (as available on iBookStore).*

Reference Books:

1. Paris Buttfield-Addison, Jonathon Manning, Tim Nugent Learning Swift: Building App macOS, iOS, and Beyond, O'Reilly Media, Inc., 3rd ed, 2018.
2. Yamacli, Beginner's Guide to iOS 11 App Development Using Swift 4: Xcode, Swift

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSP318	VR Gaming	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate the concepts, requirements and processes of VR game development.
CO2: To implement the audio-video development and production process associated with VR games.

Course Contents:

UNIT 1: **14 lecture hours**
Industrial applicability of VR, Five Classic Components of a VR System, navigation and Controllers, Position and Motion Trackers, Inside Out/Outside, Tracker Performance Parameters, Optical - Active and Passive Trackers, Inertial and Hybrid Trackers - HMD Trackers, Magnetic Trackers, Mechanical Trackers, Ultrasonic Trackers, navigation and Manipulation Interfaces, Tracker-Based navigation, Manipulation Interfaces, Three-Dimensional Probes and Controllers, Data Gloves and Gesture Interfaces, Human behind the lenses, Human Perception and Cognition, Human Visual System, Human Auditory System, Human Vestibular System, Camera tracking and 3D Rendering for Immersive Environments, Inside-Out Camera tracking, Depth Sensing, Full-Body tracking, Inverse & Forward Kinematics, Full body inertial tracking , Holographic Video.

UNIT 2: **14 lecture hours**
Rendering Architecture, Graphics Accelerators, 3D Rendering, Distributed VR Architectures, Multi-pipeline Synchronization, Co-located Rendering Pipelines, Distributed Virtual Environments, Modeling the Physical world, Geometric Modeling, Virtual Architecture, Virtual Object Shape, Virtual Object Appearance, Procedural Textures, Advanced Material Properties, Procedural Objects, Photogrammetry, Kinematics Modeling, Homogeneous Transformation Matrices, Object Position, Transformation Invariants, Object Hierarchies, Scale, Perspective and Perception, Physical Modeling, Collision Detection, Surface Deformation, Force computation, Force Smoothing and Mapping, Haptic Texturing.

UNIT 3: **14 lecture hours**
Presence, Agency and Interactivity, Augmenting the sense of Presence, Space and Architecture, Dissolving the Medium, Identity in Immersive Environments, Change of Identity, Transforming the senses, Extending the senses, Agency and Interactivity, Cybernetics, Interactivity within Physical Dimensions, Interactivity beyond Physical restrictions: the Super Hero effect, Sound in Immersive Environments, Evolution of Sound Systems, From mono to stereo to surround, Object Based Sound, Ambisonics, Sound Design Basics, Sound as Information, Earcons, Impact of Sound in Objects and Actions, natural vs Real Sound, Physical Computing, IoT and sensor networks, Rapid Prototyping.

Text Book:

1. *Glover Jesse and Jonathan Linowes, Complete Virtual Reality and Augmented Reality Development with Unity: Leverage the power of Unity and become a pro at creating mixed reality applications (1st ed.), Packt Publishing Limited, 2019. ISBN 1838648186.*

Reference Books :

1. Jerald Jason, *The VR Book: Human-Centered Design for Virtual Reality Jason Jerald* (1st ed.), NextGen Interactions 2016, ACM Books. 2016. ISBN 978-1970001129.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSP319	Augmented Reality	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course-Outcomes (COs):

On completion of this course, the students will be able to:

CO1: To articulate alternative 3D compositing techniques using computer vision with applications in interactive interfaces – most notably augmented reality interfaces on mobile devices.

CO2: To implement interactive augmented reality games and understand the practical issues regarding multi-platform reconstruction.

Course Contents:

UNIT 1: **16 lecture hours**

Industrial applicability of AR, AR Systems Overview, Input and Output Devices for AR, Optical vs. Video, See-Through AR, AR system architecture, Senses, Simple sensing/perception model, Human visual system, 3D Vision, Tracking system, Tracking for Augmented Reality, Importance of Accurate Head Tracking, Tracking Problem, Tracking Technologies, Importance of Accurate Head Tracking, Tracking Problem, Tracking Technologies, Head motion prediction, Registration, Calibration – static and dynamic, Real Time Performance, Characteristics – spatial, temporal, system robustness, Scheduling and Fusing Sensor Information, mixed reality UI design, Design of immersive user experience.

UNIT 2: **16 lecture hours**

Alternative Interface Paradigms, Usability guidelines, immersive environments, Space, Scale, Ergonomics, Physical locomotion techniques, Target based techniques, Steering, Comfort and distress, Gaze direction, comfort range test, Motion Sickness, Simulator Sickness, Cybersickness, AR Interface Design, Properties of AR Environments, Collaborative AR Interfaces, Heterogeneous AR User Interfaces, Tangible and Graspable Interaction, Tracking for Augmented Reality, Augmented Reality Interaction, Augmented Reality Information Browsers, AR Widgets, Graphical Interface Elements, Evaluating AR Interfaces.

UNIT 3: **10 lecture hours**

Video mixing, optical blending, projection devices, spatially augmented reality, Immersive virtual reality, Desktop metaphor, mobile/wearable computing, Ubiquitous computing, Tangible user interfaces, Distributed graphics.

Text Books:

1. *Alan B Craig, William R Sherman and Jeffrey D Will, Developing Virtual Reality Applications: Foundations of Effective Design (1 ed.), Elsevier Publisher, 2009. ISBN 978-0123749437.*
2. *Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, 3D User Interfaces: Theory and Practice (Usability) (2 ed.), Pearson Education, USA, 2017. ISBN 978-0134034324.*

Reference Books:

1. Erin Pangilinan, Steve Lukas, Vasanth Mohan, Creating Augmented and Virtual Realities (1 ed.), Creating Augmented and Virtual Realities (1 ed.), O'Reilly Publishers, 2019. ISBN 978-1492044192.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSP320	Game Mechanics and Game Physics	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate different types of bodies and their dynamics, used in-game programming.
CO2: To implement the collision detection and their resolution techniques.

Course Contents:

UNIT I: **16 lecture hours**

Game theory and mechanism, Normal form games, Super modular games, Dynamic games, Repeated games, Games with incomplete/imperfect information, Mechanism design, Cooperative game theory, Network games, Linear Algebra, Affine Algebra, Calculus, Physics Concepts, Newton's Law, Forces, Momenta, Energy, Rigid body physics, Rigid body classification, Rigid body kinematics, Newtonian dynamics, Lagrangian dynamics, Equations of motion for a particle, system of particles, continuum of mass, Constraints, Interpretation of equations of motion, Euler's equations of motions, Soft Bodies Physics, Elasticity, Stress and Strain, Mass- Spring Systems, 1D, 2D and 3D array of masses, Arbitrary configurations, Control point deformation, B-Spline curves, B-Spline surfaces, Surfaces built from curves.

Modulo II: **16 lecture hours**

Free- form deformation, Implicit surface deformation, Level Set Extraction, Isocurve extraction in 2D images, Isosurface extraction in 3D images, Numerical integration methods, Euler's Method, High order Taylor methods, Runge-Kutta methods, Multistep methods, Predictor-corrector methods, Extrapolation methods, Verlet Integration, Numerical Stability, Stiff Equations, Quaternion: Rotation matrices, Classical and Linear algebraic approach, From rotation matrices to quaternion, Interpolation of quaternion, Collision Detection: pipeline, Broad phase collision detection, Bounding volume hierarchies, spatial partitioning, Generation contacts: Collision geometry, Contact generation Algorithms, Separating Axis tests, Coherence.

UNIT III: **10 lecture hours**

Collision Resolution: Impulse, Torque, Collision Impulses, resolving interpenetration, The collision resolution process, Resting Contacts and Friction: Resting forces, Micro collisions, Types of friction, Stability, Optimizations, Digital Physics: Physical modelling, Accelerometer, Location based gaming, Pressure sensors, load cells.

Text Books :

1. Bourg David M and Bryan Bywalec, *Physics for Game Developers* (2nd ed.), O'Reilly Media, 2013. ISBN 978-1449361037.

Reference Books :

1. Schell Jesse, *The Art of Game Design: A Book of Lenses,* (3rd ed.), A K Peters/CRC Press, 2019. ISBN 1138632058.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSP321	Game Programming with HTML5	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To explain the fundamentals of Game Programming in HTML5 and understand the elements of programming in the two-dimensional environment for the creation of Games).

CO2: To create the games for the desktop machine and Internet using the different tools available in a major programming language like HTML5.

Course Contents:

UNIT 1: **16 lecture hours**

HTML5 Multimedia, Game framework, Frame Rate class, Creating custom rendering thread, Creating an active rendered thread, Changing the display mode, Active rendering in full-screen display mode, Handling keyboard input, Keyboard improvements, Handling mouse Input, Relative mouse movement, Points and vectors, Transformations, Transformation using the vector 2f class, Transformation using polar coordinates, Matrix transformations, Row-major vs column-major matrices, Matrix3x3f class, Affine transformation in time and space, Calculating time delta, Screen mapping, Viewport ratio, Cannon physics.

UNIT 2: **18 lecture hours**

Intersection testing, Point in polygon testing, Testing using AABB, Testing using circles for intersections, Testing using the separating axis method, Testing using the line-line overlap method, Testing using the rectangle-rectangle overlap method, Optimizing the tests, Game development setup, Exploring the Game Library, XML, Deploying an Applet, Executable JAR, Deployment of game on multiple applications, Swing animation, Component animator, Repaint Collector, Loop Governer, Animated component, Animation library, Component Painter, Component Updater, Component Animator. Advanced Graphics, Hardware-Accelerated Images, Multi-Buffering and Multi-Threading, Full-Screen Exclusive Mode, Persistent Data, Persistent data formats, Persistence mechanisms, Data Integrity, Game architecture, Interfaces and inheritance, Model-View-controller, Component View MVC, A* Algorithm, Grid Cartographer and Gradient Cartographer.

UNIT 3: **08 lecture hours**

HTTP Tunneling, Reusable Client and server-side code, Game specific client and server-side code, HTTP Polling, HTTP Pulling, HTML5 file upload and download, File API and Ajax / XHR2, Drag and drop files, Indexed DB, HTML5 Multimedia, Web Components, Web Workers, The Orientation and Device Motion APIs.

Text Book:

1. *Wright Timothy M., Fundamental Game Programming with Java (1 ed.), Cengage Learning PTR, 2014. ISBN 978-1305076532.*

Reference Books :

1. Millington IAN and John Funge, *Artificial Intelligence for games* (2 ed.), CRC Press, 2009. ISBN 978-0123747310.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSP322	AI for Games	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To comprehending an interconnection between the techniques of AI and their usage in Games.
CO2: To Implement the idea of AI in Games for developing games programmatically.

Course Contents:

UNIT 1: **14 lecture hours**

Artificial Intelligence in Games, Ways of AI in Games, Deterministic Versus Nondeterministic AI, Established Game AI, Chasing and Evading, Agent Movement, Two-Dimensional Movement, Statics, Kinematics, Steering Behaviors, Combining Steering Behaviors, Randomness in game, FSM with probability, Dynamic AI, Coordinated Movement, Motor Control, Movement in the Third Dimension, Pathfinding, Breadcrumb Pathfinding, Path Following, Wall Tracing, Waypoint navigation, A* Pathfinding, World Representations, Defining Search Area, Starting Search, Scoring, Finding Dead End, Hierarchical Pathfinding, Continuous Time Pathfinding.

UNIT 2: **14 lecture hours**

Decision Making: Finite State Machines, Rule based systems, Decision trees, Fuzzy Logic in gaming, Markov Systems in gaming, Goal-Oriented Behavior, Rule-Based AI Systems, Fighting Game Strike Prediction, Action Execution, Decisions Under Uncertainty-Bayesian Techniques, Bayesian Network, Tactical and Strategic AI, Waypoint Tactics, Tactical Analyses, Terrain Analysis, Learning with Tactical Analyses, Structure for Tactical Analyses, Map Flooding, Tactical Pathfinding, Cost Function, Tactic Weights and Concern Blending, Modifying Pathfinding Heuristic, Tactical Graphs for Pathfinding.

UNIT 3: **14 lecture hours**

Coordinated Action, Multi-Tier AI, Emergent Cooperation, Scripting Group Actions, Military Tactics, Learning mechanism, Online or Offline Learning, Intra-Behavior Learning, Inter-Behavior Learning, Over-Learning, Minimax algorithm, Negamax algorithm, Parameter Modification, Parameter Landscape, Hill Climbing in gaming, Extensions to Basic Hill Climbing, Annealing, Action Prediction, Left or Right, Raw Probability, String Matching, N-Grams, Neural Networks in gaming, Chasing and Evading with Brains, Reinforcement learning in gaming.

Text Book:

1. *Bourg David and Glenn Seemann, AI for Game Developers: Creating Intelligent Behaviour in Games (1 ed.), O'Reilly Media, 2020. ISBN 978-0596005559.*

Reference Books :

1. Yannakakis Georgios N. and Julian Togelius, *Artificial Intelligence and Games* (1 ed.), Springer, 2018. ISBN 978-3319635194.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSP323	Animation and Rendering Techniques	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To define viewpoint and common rollouts-editing splines.

CO2: To understand different concepts of light.

CO3: To make use of VRay in animation and create animation by using rendering technique.

Course Contents:

UNIT 1: **10 lecture hours**

3D View, Viewports, Standard primitives, Transformations, File formats and operations, Selection, Cloning, Group, Ungroup, Alignment, Splines: common, Rollouts-editing splines, Architectural tools, Max scene files, Modifiers, World space modifiers, Object space modifiers, Modifier stack, Instanced modifier.

UNIT 2: **14 lecture hours**

Compound objects and types, Modelling, mesh modelling, converting objects to editable mesh, sub objects: vertex, edge, face, polygon, element, Edit mesh modifier, Editable poly modelling, Material Editor, Assigning materials to objects, Material editor options, Material properties, Material types, Concepts of Light, omni lights, Spotlight, target lights, free lights, directional light, area lights, Mental ray, Skylight, Creating max basic lights, lights parameters, Positioning lights, Creating max light in exterior environment, Creating max light in interior environment.

UNIT 3: **12 lecture hours**

Introduction to Network Security, Network-based Attacks, Active and Passive Attacks, Phishing and Its Types, Tailgating, Impersonation, Dumpster Diving, Shoulder Surfing, Hoax, Waterhole Attacks, Denial of Service Attacks and its Types, Man in the Middle Attack, Buffer Overflow Attack, Cross-Site Scripting, SQL Injection Attack, Privilege Escalation, Man in the Browser, Zero-Day Attack, SQL Injection Attack, Privilege Escalation, Man in the Browser.

UNIT 4: **06 lecture hours**

Animating modifiers, animating elements, animation helpers, using dummy objects, dynamics and reaction, Dynamic Objects: damper, Spring, simulation mass FX.

Text Book:

1. *Watt Alan H. and Mark Watt, Advanced Animation and Rendering Techniques Theory and Practice (1 ed.), ACM Press, 1992. ISBN 9780201544121, 0201544121.*

Reference Books :

1. Möller Tomas Akenine, *Eric Haines and naty Hoffman, Real-Time Rendering* (3 ed.), CRC Press, 2019. ISBN 9781315362007, 1315362007.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Open Elective

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSO401	Applications of AI	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Know various AI Agents and AI search algorithms (uninformed, informed, heuristic, constraint satisfaction, genetic algorithms).
CO2: Demonstrate working knowledge of reasoning in the presence of incomplete and/or uncertain information.
CO3: Apply knowledge representation, reasoning, and machine learning techniques to real-world problems.

Course Contents:

UNIT 1: **16 lecture hours**

Introduction: Introduction to Artificial Intelligence, Foundations and History of Artificial Intelligence, Introduction to Search: Searching for solutions, Uniformed search strategies, Informed search strategies, Local search algorithms and optimistic problems, Adversarial Search, Search for games, Alpha - Beta pruning, Applications of Artificial Intelligence. Markov decision processes, Intro to neural nets.

UNIT 2: **12 lecture hours**

Reasoning with uncertainty, Probabilistic reasoning over time Learning Gaming: Movement, Decision Making, Strategy, Infrastructure, Agent-Based AI.

UNIT 3: **08 lecture hours**

Hacks and Heuristics. Vision Systems: fundamentals of image formation, camera imaging geometry, feature detection and matching, Multiview geometry.

UNIT 4: **06 lecture hours**

Motion estimation and tracking, and classification, Action recognition Color spaces and Segmentation.

Text Book:

1. *Russell, Stuart J., and Peter Norvig. Artificial intelligence a modern approach. 3 ed. Prentice Hall, 2010.*

Reference Books :

1. Forsyth, David A., and Jean Ponce. *Computer vision: a modern approach*. 2 ed. Prentice Hall, 2011.
2. Millington, Ian, and John Funge. *Artificial intelligence for games.* 2 ed. CRC Press, 2009.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSO402	Web Technologies	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To explain the development and transition of the web.
CO2: To learn creating the web pages and apply the styles.
CO3: To implement web-based application and deploy it.

Course Contents:

UNIT 1: **8 lecture hours**

Introduction to Web Technologies, History of the Web, OSI Reference Model, Understanding Web System Architecture, understanding 3-Tier Web Architecture, Layers in the TCP/IP Model, Web Browsers, Overview of HTTP, Exploring Web Technologies, Introduction to Web Services, About IIS, Services Supported by IIS7, Installation of IIS7, Administer Web Server Remotely, Creating Web Sites.

UNIT 2: **9 lecture hours**

Introducing HTML Document Structure, Creating Headings on a Web Page, Working with Links, Creating a Paragraph, Working with Images, Working with Tables, Working with Frames, Introduction to Forms and HTML Controls, Introducing Cascading Style Sheets, Introducing DHTML, Introducing JavaScript, Client-Side Benefits of using JavaScript over VB Script, Embedding JavaScript in an HTML Page, Handling Events, Using Variables in JavaScript, Using Array in JavaScript, Creating Objects in JavaScript, Using Operators, Working with Control Flow Statements, Working with Functions.

UNIT 3: **9 lecture hours**

Introducing PHP , Working with Variables and Constants, Controlling Program flow, Working with Functions, Arrays, Files, and Directories, Working with Forms and Database, Databases : Basic command with PHP examples, Connection to server, creating database, selecting a database, listing database, listing table names creating a table, inserting data, altering tables, queries, deleting database, deleting data and tables, PHP myadmin and database bugs, Exploring Cookies, Sessions, and PHP Security.

UNIT 4: **8 lecture hours**

Getting Started with Web Applications in Java, Working with JavaBeans, Working with Servlet Programming, Working with JSP, Java Database Programming, ASP.NET 3.5 Essentials, Developing a Web Application , Application Structure and State, Web Forms: Standard Controls, Navigation Controls: Tree View, Menu, and Site Map Path, Validation Controls, Introducing Web Parts Controls, Working with Database Controls, Introducing Login Controls, Inside Master Pages and Themes, Managing Web Applications, Application Globalization.

UNIT 5: **8 lecture hours**

Introduction to XML, Basic and advance XML, Java API for XML Processing, Document Object Model (DOM), XML Linking Mechanism, Evolution of Web Application, Understanding JavaScript

for AJAX, Asynchronous data transfer with XML Http Request, Implementing AJAX Frameworks, Integrating PHP and AJAX, Consuming Web Services in AJAX .application in IT sector

Text Books:

1. *Kumar, Akshi. Web technology: theory and practice. 1st ed. CRC Press, 2018.*
2. *Meloni, Julie C. Sams teach yourself HTML, CSS, and JavaScript all in one. 3rd ed. Sams Publishing, 2019.*

Reference Books :

1. Robbins, Jennifer Niederst. *Learning web design: A beginner's guide to HTML, CSS, JavaScript, and web graphics*. 1st ed. Springer InternationalPublishing, 2018.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSO403	Semantic Technology	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To explain the modelling of information and knowledge.
CO2: To examine RDF and OWL Technologies.
CO3: To Implement sophisticated querying approaches for facilitate distributed information retrieval and aggregation.

Course Contents:

UNIT 1: **9 lecture hours**

Evolution of web technologies; Shortcomings of the traditional web; General scheme of knowledge representation models; Brief historical information on thedevelopment of models; Knowledge-based systems and examples; Types of logic models; General terms and definitions; Formal (Aristotleva) logic: Names,Statements, Proof, and rebuttal procedures; Mathematical implementation of formal logic; Methods of automatic theorem proof (calculation of predicates). Fuzzysets; Definition of concepts: ontology, concept, attitude, axioms. Examples of ontologies.

UNIT 2: **8 lecture hours**

The concept of Semantic Web; Multilevel representation; Semantic Web applications; Main tendencies of development of Internet technologies; Electroniccommerce; Auctions; Information collection and management; Personal assistants; Scientific and educational information environments; Electronic tourism; E-government; Bioinformatics; Semantic Grid; Business process management; Semantic Web SPARQL query language; Simple queries; Thermas; Literals;Variables; List of predicates-objects.

UNIT 3: **12 lecture hours**

Anonymous nodes; RDF collection; Samples of triplets; Sample solutions; Multiple comparisons; Working with RDF literals; Comparison of RDF literals;Limitations of values; Samples of graphs; Combination of samples; RDF data sets; RDF data set queries; Description of RDF datasets; Solutions and resultforms; Selection of variables; Building the resulting graph; Resource descriptions; Explicit IRI. Resource identification; Functions and operators of SPARQL;Description of resources in RDF language; OWL ontology description language; Standard metadata views; FOAF technology; Intelligent agents; Multi-agenttechnologies.

UNIT 4: **13 lecture hours**

Data processing algorithms in Semantic Web; Semantic Web services; Ontologies of web services modelling; Service description: profile, process model,interaction (grounding); Stages of work with web services: annotation, detection, handling, composition; Monitoring of service performance; Specifications forsemantic web services: WSMO, WSML; WSMX, OWL-S, SWSF; IRS-III, WSDL-S; Methods, Algorithms, and tools to detect and compose web services;Examples of service descriptions; Options for using discovery and service compositions in an enterprise B2B system.

Text Book:

1. *Yu, Liyang. Introduction to the semantic web and semantic web services.1st ed. Chapman and Hall/CRC, 2019.*

Reference Books :

1. Alor-Hernández, Giner, José Luis Sánchez-Cervantes, Alejandro Rodríguez-González, and Rafael Valencia-García, eds. *Current trends in Semantic Web technologies: Theory and practice*. 1st ed. Springer, 2019.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSO404	IT Support Technologies	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Understand the need for IT Support Technologies.

CO2: To articulate network security and firewall concepts.

Course Contents:

UNIT 1: **13 lecture hours**

Introduction to IT Support; Need for IT Support; Software Support; Hardware Support; Network Support; The Human Factor; Assumptions; Language Barrier;Understanding End User; Staff Training; Structuring Training and Education; Support Methodology; Flow Logic and Troubleshooting; Querying Users;Understanding IT System Issues; IT System Structure; Peripheral Issues; Understanding Environmental Factors; Documentation and Reporting; CreatingTroubleshooting Guides; First-Line Support; Paperwork; Second- and Third-Line Support Paperwork; Engineer Paperwork; Administrative Tools; PerformanceMonitoring Tools; Custom Views; Task Manager; Error and Status Information; Event Details; Event Logs; Error Logs; Remote Support Tools; Remote Desktop;Remote Assistant.

UNIT 2: **15 lecture hours**

Evolution of Computers; Aging Technology; Interface Standards; USB; Firewire; Serial; Parallel; Unix Event Catalogue; Linux Systems; Windows NT; WindowsvNext; LANs; WAN; SD-WAN; Types of WAN; Packet Switching Networks; Circuit Switching Networks; Overlay Networks; Packet over SONET/SDH;Asynchronous Transfer Mode; Frame Relay; Metropolitan Area Network; TCP/IP Protocol Stack; Cabling; Hubs; Switches; Routers; Repeaters; Topologies;Cloud Services; Cloud Software; Cloud Platforms; Software as a Service (SaaS); Platform as a Service (PaaS); Infrastructure as a Service (IaaS); ServerVirtualization; Types of Server virtualization; Advantage of Server Virtualization.

UNIT 3: **14 lecture hours**

Security Concerns in IT; Network Security; Security Threats; Network Attack; Types of Network Attack; Cryptography; Confidentiality; Data Integrity;Authentication; Non-Repudiation; Symmetric Key; Symmetric Key Algorithms; Applications and Drawbacks; Asymmetric Key; Asymmetric Key Algorithms;Applications and Drawbacks of Asymmetric; Key Algorithms; Digital Signatures; Digital Signature Algorithms; Notions of Security; Firewalls; DevelopingSecurity Policy; Firewall Configuration Strategies; E-mail; E-mail Protocols; Secure E-mail; Importance of Email Security; Best Practices for Email Security; IPsecurity; Uses of IPSec; Component of IPSec; SSL; TLS; SSL certificate; Trends and Challenges in IT Support.

Text Books:

1. *Richard, Deal. Cisco ASA configuration. 1st ed. Tata McGraw-Hill Education, 2009.*
2. *Stallings, William. Data and computer communications. 9th ed. Pearson Education India, 2010.*

Reference Books :

1. Buyya, Rajkumar, James Broberg, and Andrzej M. Goscinski, eds. *Cloud computing: Principles and paradigms*. 1st ed. MIT Press, 2011.
2. Forouzan, Behrouz A. *Data communications and networking*. 5th ed. McGraw Hill, 2007.
3. Tanenbaum, Andrew S. *Computer networks*. 5th ed. Prentice Hall, 2010.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSO405	Software Engineering	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate Software Engineering as an iterative and systematic process.
CO2: Make use of development life cycle through the IDE, UML, and Git.

Course Contents:

UNIT 1: **12 lecture hours**

Importance of Software Engineering, Phases of software development lifecycle, SDLC case study, Software Process Model, Waterfall model, Prototyping model,Incremental model, RAD model, Spiral model, Version Control System.

UNIT 2: **10 lecture hours**

Check-in and check-out code in repository, Create branch and merging branch, Need of agile, Agile manifesto, Agile principles, Agile development methods,Extreme programming (XP), XP principles, Test first development, Refactoring.

UNIT 3: **10 lecture hours**

Requirement engineering, User stories, Acceptance criteria, Requirement validation and verification, UML, Behavioral UML diagrams, Structural UML diagrams.

UNIT 4: **10 lecture hours**

Software quality assurance and testing, Designing test cases, Black Box testing, White box testing, Black box vs. white box testing, Control flow testing technique.

Text Book:

1. *Pressman, Roger S. Software engineering: a practitioner's approach. 7th ed. McGraw Hill International, 2014.*

Reference Books :

1. Sommerville, Ian. *Software Engineering.* 10th ed. Person Publications Publishing Company, 2015.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSO406	Programming Languages	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To explain the requirement for the interdisciplinary application of programming languages.
CO2: To build the logic for the given problem.
CO3: To develop programs and debug.

Course Contents:

UNIT 1: **10 lecture hours**

Programming, programming language. Types of programming languages, high level vs low level, compilers, interpreters, assemblers, binary code. Datatypes, variables, keywords, identifiers, Importance of comments in programming. Implementation of scope rules. Static scoping and dynamic scoping.

UNIT 2: **11 lecture hours**

Programming constructs: conditional statements if statements, else statement, if-else statement. For loop, while loop, nesting loop. Do-while loop, infinite loops, break, continue statements. Arrays, one dimensional array, multidimensional array.

UNIT 3: **10 lecture hours**

Functions, in-built functions vs user-defined functions, importing libraries for using in-built functions. Pointers and its types, arrays of pointers, pointers, and functions. Passing parameters to functions, returning values from functions, recursion. Dynamic arrays, string, string variables, string handling functions.

UNIT 4: **11 lecture hours**

Object-oriented paradigm. Fundamental concepts, objects, classes, encapsulation, and inheritance. Errors and warnings, rectifying errors and debugging. File handling, opening and closing file, input / output operations on file.

Text Books:

1. *Bansal, Arvind Kumar. Introduction to programming languages. 1st ed.), Chapman and Hall/CRC, 2017.*
2. *Kanetkar, Yashavant, and Aditya Kanetkar. Let Us Python Solutions: Learn by Doing-the Python Learning Mantra. 1st ed. BPB Publications, 2020.*

Reference Books :

1. Klabnik, Steve, and Carol Nichols. *The Rust programming language*. 1st ed. No Starch Press, 2023.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSO407	Artificial Intelligence for Creative Expression	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To explain the creative expression possibilities of artificial intelligence.
CO2: To create artistic experiments and prototypes, in a variety of output forms like visual, textual, musical.
CO3: To examine the implication of AI in the field of creative expressions, which was human territory till now.

Course Contents:

UNIT 1: **14 lecture hours**

What is machine learning? Playing around with Wekinator and Tensorflow.js to start making some interactive work and get familiar with concepts of training the machine with some data, running a trained model and seeing interactive output. What are neural networks? Looking inside neural networks and how neural networks are trained, understanding what terms like weights of a network, activation function etc. mean. Convolutional neural networks and how that leads to Deep dream. Experiments with deep dream to visualize layers.

UNIT 2: **14 lecture hours**

Discussions around how AI is like a photography moment for art to give some art historical context to AI. Style transfer- real-time style transfer from pre-trained models. Run style transfer experiments through webcam input. Discussions around how artists are using style transfer.

UNIT 3: **7 lecture hours**

Recurrent neural networks- Text Modeling, Sketch (vector drawing) Modeling, Music Modeling. Introduction to sequential datasets in the context of art, like quickdraw, text corpuses and musical datasets and what can be done with such sequential data. Ethical considerations around widespread use of AI. Conceptual art pieces that comment on this issue.

UNIT 4: **7 lecture hours**

Dimensionality reduction algorithms like TSNE, and how they can be used to form interactive ways of exploring data. Example art pieces using this. Generative models- Generative Adversarial Networks (GANs). Understanding the basic formulation of a GAN. Pipeline of how to train a GAN for art. GAN latent space arithmetic.

Text Book:

1. *Marcus Du Sautoy, The Creativity Code, Art and Innovation in the Age of AI. 1st ed. Harvard University Press, 2020.*

Reference Books :

1. Kevin Ashley, *Make Art with Artificial Intelligence, Make and Sell Your Art with AI, Blockchain and NFT.* 1st ed. Independently published, 2021

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSO408	AI and Public Policy	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To explain the policy frameworks and strategy reports by different countries and organizations.
CO2: To articulate the arguments for AI laws related to Autonomous and Robotics systems.
CO3: To make use of legal framework and challenges concerning AI and Data science.

Course Contents:

UNIT 1: **11 lecture hours**

AI: An opportunity and a risk, Comparing and interpreting the strategy and reports of different countries on Artificial Intelligence: Singapore, USA, UK, Germany, India, China, Blockchain: Japan, China, USA, Switzerland, Singapore, India, Robotics: Singapore, Japan, USA, India, International AI Strategies: European Union, United Nations, AI Agreement between UAE and India, International Study Group of AI.

UNIT 2: **13 lecture hours**

AI Policies in India: NITI Aayog, AI initiatives by Ministry of Electronics and IT, AI Initiative by Ministry of Commerce and Industry, National AI based portal, AI Academia/ Institutes and Centers in India, AI standardization in India: Bureau of Indian Standards (BIS), Department of Telecom (DOT), Key considerations for AI policymaking in India: Resources, Infrastructure, Markets, and Funding, Policy environment for AI innovation, Democratize AI technologies and data, National infrastructure to support domestic development: AI Data Storage, AI Networking Infrastructure, Awareness, Education, and Reskilling: Skill sets to successfully adopt AI, Early Childhood Awareness and Education, Focus on marginalized groups, Improved access to and awareness of Internet of Things, Public Discourse, Impact of AI on different stakeholders: Employees, Customers, Business, etc., How has COVID-19 affected the AI trends?, Business Transformations with AI.

UNIT 3: **8 lecture hours**

AI in warfare and diplomacy, AI shortfalls for military applications, Transparency in AI, Audits, Tiered Levels of Transparency, AI and economic growth: Economic characteristics of AI, Private equity investments in AI start-ups, Broader trends in development and diffusion of AI, How increases automation in the production of goods and services is impacting economic growth?, How can we reconcile the advent of AI with the observed constancy in growth rates and capital share over most of the twentieth century?, Should we expect such constancy to persist in the twenty- first century?, Can AI drive massive increases in growth rates? Under what conditions, and are these conditions plausible?, How are the links between AI and economic growth modulated by firm- level considerations, including market structure and innovation incentives?, How does AI affect the internal organization of firms, and with what implications?

UNIT 4: **10 lecture hours**

Documentary on Impact of AI in economy, Case study: How do you organize the skills to best facilitate innovation for your firm?, Pitch deck for ideas or new application of AI, Pitch deck for ideas or new application of AI, Coordination and collaboration across stakeholders, Development of Contextually Nuanced and Appropriate AI Solutions Continuing, deepening, and expanding partnerships for innovation, Develop contextual standard benchmarks to assess quality of algorithms, Frameworks for Regulation: National legislation, Data Protection Law, Discrimination Law, Frameworks for Regulation:

Competition Law, Consumer Protection Law, Sectoral Regulation, AI Policy Challenges: Intellectual Property Regime and AI issues, Catastrophic and Existential Risk, AI Policy Challenges: Security and Cyber security, Re-thinking Intellectual Property Regimes.

Text Book:

1. *West, Darrell M., and John R. Allen. Turning point: Policymaking in the era of artificial intelligence. 1st ed. Brookings Institution Press, 2020.*

Reference Books :

1. Sarangi, Saswat, and Pankaj Sharma. *Artificial intelligence: evolution, ethics and public policy.* 1st ed. Taylor & Francis, 2019.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSO409	Linux Apache MySQL PHP (LAMP)	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Contents:

UNIT 1: **10 lecture hours**

LAMP technology, Linux Operating System, Knowledge of various editors, PHP introduction, Operators in PHP, Logical and conditional operators use cases, Function Definition and Function Call, Function with arguments, Function with return value, call by value and call by references.

UNIT 2: **11 lecture hours**

Understanding variable scope, Global Variables and Static Variables, Include and Require, Built-in functions in PHP, Introduction to Array, Array in PHP, Creating an Array, Accessing Elements of an Array, Modifying Elements of an Array, Array and string related operations.

UNIT 3: **11 lecture hours**

OOPs Concepts, Defining Class in PHP, Object in PHP, Constructor, Constructor with Parameters, Introduction to Exception, Exception Handling mechanisms, Creating Custom Exceptions, Multiple Catch Blocks, Exception Propagation, Error Handling in PHP, Web designing principles.

UNIT 4: **10 lecture hours**

HTML, CSS, Java script, supporting tools and CMS, Introduction to MySQL, Learning the MySQL Data Types, Frequently used String functions in MySQL, Regular expressions and their uses in PHP, Cookies, Session variable, its session ID management, File handling in PHP.

Text Book:

1. *McPeak, Jeremy. Beginning JavaScript. 5th ed. Wrox Publication, 2015.*

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSO410	Software Testing	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1 : To articulate the various software testing methods.
CO2 : To make use of the various test cases for different types and level of testing.

Course Contents:

UNIT 1: **10 lecture hours**

Software testing, testing objectives. Principles of Software Testing, Testing and debugging, Test metrics and measurements.

UNIT 2: **11 lecture hours**

Verification, Validation and Testing, Software Quality and Reliability, Software defect, Manual and Automation Testing, Software Testing Life Cycle, Phases of STLC, Test Case Preparation.

UNIT 3: **10 lecture hours**

Testing Techniques: White Box Testing, Black Box Testing, Unit Testing, Integration Testing, User Acceptance Testing, Alpha and Beta Testing, Smoke Testing, Sanity Testing, Regression Testing.

UNIT 4: **11 lecture hours**

Formal Testing, Informal Testing, Monkey Testing, Re-Testing, Load/Stress Testing, Ad hoc Testing: Pair testing, Exploratory testing, Iterative testing, Defect seeding.

Text Book:

1. *Limaye, Vaishali S. Software Testing - Principles, Techniques and Tools. 1st ed. McGraw Hill Education, 2017.*

Reference Books:

1. Pressman, Roger S. *Software engineering: a practitioner's approach.* 7th ed. McGraw Hill, 2019.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSO411	Computing Start-ups	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1 : Understanding of computing start-ups.
CO2 : How technology can change or upswing the scenario.
CO3 : Proposed an idea for start-up and applicability of technology (Idea to Start-up).

Course Contents:

UNIT 1: **20 lecture hours**

What Does It Mean to Be a Startup Entrepreneur? Engaging Others with Actionable Next Steps, Benefits vs. Features, Simple Strategies to Get Unstuck, The Financial Model, The Legal Setup of Your Startup, Meetings and Communication Skills.

UNIT 2: **22 lecture hours**

Startup Grants: Can Government Programs Stimulate Entrepreneurship? Venture Capital and Angel Investors Incubators and Accelerators Incubators and Accelerators, Moving Past the Startup Stage, How Universities Can Support Their Startups Today.

Text Book:

1. *Brahim, Bachir . The Colony of Innovative Startups. 1st ed. Bachir BRAHIM, 2020.*

Reference Books :

1. Wright, Mike, and Philippe Mustar. *Student start-ups: The new landscape of academic entrepreneurship*. 1st ed. World Scientific, 2019.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSO412	Career Skills for IT Companies	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To impart aptitude, reasoning, technical and soft skills that would aid in the employability of the students.
CO2: To develop both personal and professional skills effectiveness.
CO3: To help students to gain a confidence for the upcoming placements.

Course Contents:

UNIT 1: **16 lecture hours**

Introduction to Problem Solving; Prime Numbers; GCD; LCH; HCF; Theorems of Divisibility; Divisibility Rules; Remainder Theorem; Counting; Arithmetic Progression; Geometric Progression; Harmonic; Progression; Averages; Allegations; Ratio; Proportion; Variation; Interest; Time and Work; Negative Work; Product Constancy; Equivalence Method; Efficiency; Pipes and Cisterns; Boats; Relative Motion; Opposite Motion; Straight Lines; Polygons; Triangles; Quadrilaterals; Circles; Tangent; Eclipse; Star; Functions: Tabular, Graphical, Even Odd, Inverse; Inequalities; Logarithmic; Graphical View of Logarithmic; Properties of Inequalities: Notion of Ranges, Linear Inequality, Quadratic Inequality; Permutation; Circular Permutation; Combination; Probability; Real Life Estimation of Probability: Conjunction AND, Conjunction OR; Concept for Odds for and Odd Against; Set Theory; Operations; Algebra; Coordinate Theory; Cartesian Coordinate System; Rectangular Coordinate Axes.

UNIT 2: **14 lecture hours**

Data Interpretation: Representation of Data, Nature of Data, Capturing of Data, Organization of Data, Tables, Bar Charts, X-Y Charts, Pie Charts, Cases; Logical Reasoning; Reasoning Analogies; Artificial Language; Calendar; Cause and Effect; Clocks; Critical Path; Directions; Data Interpretation; Deduction Reasoning; Statement Analysis; Data Sufficiency; Puzzles; Pattern Series; Embedded Images; Figure Matrix; Picture Series; Pattern Series; Shape Construction; Statement and Assumptions; Statement and Conclusions; Syllogism; Verbal Reasoning.

UNIT 3: **12 lecture hours**

Communication Skills; Listening Skills; Team Building; Assertiveness; Group Discussions; Personal Interview; HR Communications; Specific Applications; Essay; Memo; CV; Business Letter; Press Release; Policy and Project Proposal; Report; Minutes; Email; Social Media for Professional Purposes; Editing Documents; Crisis Communication; Getting your Ideas Across.

Text Books:

1. *Sharma, Arun. How to prepare for Logical Reasoning for CAT. 6th ed. McGraw Hill Education, 2021.*
2. *Sharma, Arun. Quantitative Aptitude. 8th ed. McGraw Hill Education, 2021.*
3. *Gutbrod, Hans. Handbook for Professional Communication: How to get your ideas across, every single time. 1 ed. Verlag GD Publishing Limited and Co KG, 2020.*

Reference Books :

1. Agarwal, R.S. *Quantitative Aptitude for Competitive Examinations.* 1st ed. S Chand Publishing, 2017.
2. Agarwal, R.S. *A Modern Approach To Verbal & Non-Verbal Reasoning*, 2nd ed. S Chand Publishing, 2017

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	**Bachelor of Technology (Computer Science and Engineering)**				
BCSO413	**Cyber security: Impact on Govts, Policies and Economics**	L	T	P	C
Owning School/Department	**Computer Science and Engineering**	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To explain the broader picture of cybersecurity at the world stage. To articulate the arguments for Cybersecurity related policy frameworks.

CO2: To examine the cybersecurity related challenges facing the world.

Course Contents:

UNIT 1: **10 lecture hours**

Definition of Cybersecurity; Key Concepts in Cybersecurity; Threats to Cybersecurity; Compromises to IP, Deviations in QoS, & Espionage or Trespass; Forces of Nature, Human Error or Failure & Information Extortion; Sabotage or Vandalism, Software Attacks & Technical Hardware Failures; Technical Software Failure, Technological Obsolescence, and Theft. Security Technologies; Access Control; Firewalls; Intrusion Detection and Prevention Systems; Virtual Private Networks, Vulnerabilities in Information Assets, Understanding Vulnerabilities and Vulnerability Assessment, Vulnerability Assessment: Tools and Techniques, Vulnerability Remediation Strategies, Configuration and Change Management in Vulnerability Assessment.

UNIT 2: **10 lecture hours**

Governance, Risk Management, and Compliance (GRC) approach to Managing Cybersecurity; Management of Cybersecurity; Cybersecurity Personnel: Roles and Responsibilities; Cybersecurity & Personnel Issues; Cybersecurity Governance and Planning; Cybersecurity Strategic Planning; Cybersecurity Planning for Contingencies; Cybersecurity Risk Management; Risk Management: Models and Methodologies; Preparation for Risk Management; Risk Assessment; Risk Treatment; Cybersecurity Policy; Enterprise Cybersecurity Policy; Issue Specific Cybersecurity Policies; System Specific Security Policies; Developing and Implementing Effective Cybersecurity Policy; Enterprise Cybersecurity Policy; Performance Measures in Cybersecurity; Specifying Cybersecurity Measurements; Law and Regulation in Cybersecurity; Key Security Laws; Privacy Laws.

UNIT 3: **10 lecture hours**

The Role of Intelligence and Information Sharing; Design and Operation of the Internet; Internet Naming and Routing Protocols; Cyber Exploits; Major Cyber Attacks; Secure Communications and Authorization; Cyber Conflict; Cyber Economics; Contingency Planning; Contingency Planning Methodology; Business Impact Analysis; CP Strategies - Data Backup and Recovery; Incident Response; Incident Response Planning; Incident Response: Detection, Containment and Recovery, Disaster Recovery; Disaster Recovery Planning; Disaster Classifications; Planning for Disasters; Disaster Preparation.

UNIT 4: **12 lecture hours**

History and Role of United nations in setting the norms and guidelines for cybersecurity challenges across the borders; Application in International laws to Cyberspace; Case studies of few countries exploiting the internet space to their advantage; Cybersecurity issues with the increase in Global data centres; Cloud Computing and exponential increase in data storage systems; Cyber control systems;

Cyber command systems; Cyber warfare; Cyber Soldiers. and battalions; Cyber resilience; Use of Cyberspace as part of defence strategy; State surveillance; Cyber freedom; trade-off between privacy and security; Case studies to new dimensions of cybersecurity for public, Govts and Economies.

Text Books :

1. Burkart, Patrick, and Tom McCourt. *Why Hackers Win: Power and Disruption in the Network Society*. 1st ed. University of California Press, 2019.
2. Caravelli, Jack, and Nigel Jones. *Cyber security: Threats and responses for government and business*. 1st ed. Praeger Publishers Inc, 2019.

Reference Books :

1. Fields, Ziska. *Handbook of research on information and cyber security in the fourth industrial revolution*. 1st ed. IGI Global, 2018.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSO414	AI and Society	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To articulate the ethical issues related to the development and adoption of AI.
CO2: To examine the ways in which AI is impacting culture and communities.
CO3: To understand the impact of AI to make it more useful.

Course Contents:

UNIT 1: **10 lecture hours**

Terminology of AI, realistic view of AI, AI Timeline, AI system illustrations, AI Failures / Challenges, Case study /Critical discussions on current applications of AI across a range of domains and sectors: Finance: Conventional risk models, Environmental, Social, and Governance (ESG) Criteria, Chatbots and Virtual Assistants, Relationship Manager Augmentation , Health care: Health data management, Treatment pathway design, Surgical robots, Supporting pharma: drug creation and clinical trials, Agriculture: Intelligent spraying of chemicals, AI-based robots for farm harvesting , National security: Emerging Threats in the AI Era, Autonomous weapons systems, Risks associated with AI-Enabled Warfare, Art and culture: Virtual visits, Language Preservation, Interpreting expressions, Painting by numbers.

UNIT 2: **16 lecture hours**

AI Ethics: Human-centred values and fairness, Ethical governance, Ethical auditing, Ethical Issues, Data access problems Healthcare Sector - Ethical Considerations, Explainable AI, Model interpretability: Global Interpretation and Local Interpretation, The Trade-off Between Accuracy and Interpretability, Interpretation Techniques: Feature Importance, Partial Dependence Plots, Local Interpretable Model-agnostic Explanations, Transparency in AI: Model Cards, Datasheets for Datasets, Fact Sheet, Fairness: AI Fairness 360, AI Explainability 360 Decision Tree, Bias in AI, Types of Bias: Observer bias, Prejudice bias, cognitive bias, Exclusion bias, Racial bias in healthcare risk algorithm, AI learning unhealthy stereotypes, Combating Bias in AI: Use less bias or more inclusive data, Diverse workforce, Legal liability: Manufacturer (Product) Liability, Product Liability Defenses Applied to AVs, Insurance Liability, Insurer's Key Challenges, Autonomous Vehicle Levels. Product Liability Defenses Applied to autonomous vehicle, Liability Due to Hacker Attacks, Role of the Regulatory Bodies.

UNIT 3: **9 lecture hours**

Attacks on AI: Adversarial attacks, Physical attacks, Membership inference attack, The Need for Responsible AI Understanding the AI system's functioning for safe and reliable deployment, Post-deployment–can the relevant stakeholders of the AI system understand why a specific decision was made, Consistency across stakeholders, Incorrect decisions leading to exclusion from access to services or benefits, accountability of AI decisions, Dimensions of AI Accountability: Assess governance structures, Understand the data, Define performance goals and metrics, Review monitoring plans, AI and Data Privacy: AI policy options for privacy protection, Policy documents and working drafts on Artificial Intelligence, Societal Considerations in AI: Technology Based Approach for Managing AI Systems, Principles for Responsible Management of AI Systems, Societal Considerations in AI: Impact of AI on job displacement.

UNIT 4: **7 lecture hours**

Case study: Future in the balance? How countries are pursuing an AI advantage, Review of Global Regulatory Landscape, Guidelines for Trustworthy AI, Preparing for job transformation and building skills, Role of AI in the ecosystem for persons with Disability: Personalisation and Customisation, Neurosymbolic AI, Recommendations for Integrating Gender Equality into AI Principles, The Effects of AI On Child Psychology, Principles for AI in society, Guidelines for AI developed by stakeholders, How do countries seek to develop competitive advantage in AI?, Faster conditions, Demand conditions, Related and supporting industries .

Text Book:

1. *Kumar, Puneet, Vinod Kumar Jain, and Dharminder Kumar, eds. Artificial Intelligence and Global Society: Impact and Practices. 1st ed. CRC Press, 2021.*

Reference Books :

1. OECD. *Artificial Intelligence in Society.* 1st ed. OECD-Paris, 2019.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSO415	Special Topics in Computer Engineering	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: To familiarize and learn about the latest trends and research in the field.
CO2: To equip themselves with the conceptual and practical experience of few latest methods, tools, technologies or algorithms in Computer Engineering.

Course Contents:

UNIT 1: **42 lecture hours**

This course covers the cutting-edge topics in Computer Engineering, and these units will be chosen by the instructor based on the requirements and relevance at that point of time. These units need to be relevant to the industry and start-ups will also include related case studies, use cases and implementations scenarios. Students will be working on lab work and projects to get real hands-on experience of these topics and units.

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSO416	Search Engine Optimization	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Understand main search engine optimization techniques for business websites.
CO2: Analyze keyword research, writing optimized content, getting web pages indexed by search engines and tracking the outcomes.
CO3: Implement gain access to new online tools and resources to help implement successful SEOcampaigns.

Course Contents:

UNIT 1: **16 lecture hours**

Search engine, Search engine optimization (SEO), need of SEO, Googlebot (Google Crawler), Types Of SEO technique, Google's SEO Algorithm updates, planning and strategies for SEO, SEO tools, Technical SEO, Technical SEO Ranking factors, Type of meta tags, effect on SEO, Website architecture Optimization, Breadcrumbs, Permalinks optimization, Canonicalization, Setup of CDN, SSL, Improve Website Performance, Speed using Plugin, perform the Page Speed Test, XML and HTML sitemap creation and optimization, Add and verify a website in Google Console, Google Analytics setup and monitoring.

UNIT 2: **14 lecture hours**

Keyword, importance of Keyword Research, types of keywords, Analysis of keywords using Tools, easy to rank keywords, Analysis of Keyword, find Ranking Keyword of competitor, selecting right keywords, Top ranking Keywords of your sites, Find hidden ranking keywords of your website, LSI Keywords: Easy Strategies To find LSI Keywords, Content Research, Content Structure, Content Planning with Keywords, Internal links, Outbound link, Schema Markup.

UNIT 3: **12 lecture hours**

YouTube SEO Ranking Factors, Video Optimization, Title Optimization, Description Optimization, Thumbnail Optimization, Increase YouTube Subscribers Organically, SEO Strategy from Google Search Console & Google Analytics, maintain the position of existing ranking keywords, keep Eyes On Competitor Ranking Keywords.

Text Book:

1. *Das, S., Search Engine Optimization and Marketing: A Recipe for Success inDigital Marketing (1st ed.), CRC Press, 2021. ISBN 978-0367278786.*

Reference Books :

1. Clarke, A., SEO 2022: Learn Search EngineOptimization with Smart Internet Marketing on line **416** LLC 2022. ISBN 9780578333380,0578333384

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSO417	Growth Hacking	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Integrate the data-driven and adaptive culture of Growth Hacking to improve digital marketing results.
CO2: Tell better stories and write marketing content to improve conversion rates.
CO3: Understand the economics of customer interactions and may build business tools that automate repetitive tasks in order to gain access to new data.

Course Contents:

UNIT 1: **11 lecture hours**

Search engine, Search engine optimization (SEO), need of SEO, Googlebot (Google Crawler), Types Of SEO technique, Google's SEO Algorithm updates, planning and strategies for SEO, SEO tools, Technical SEO, Technical SEO Ranking factors, Type of meta tags, effect on SEO, Website architecture Optimization, Breadcrumbs, Permalinks optimization, Canonicalization, Setup of CDN, SSL, Improve Website Performance, Speed using Plugin, perform the Page Speed Test, XML and HTML sitemap creation and optimization, Add and verify a website in Google Console, Google Analytics setup and monitoring.

UNIT 2: **12 lecture hours**

Keyword, importance of Keyword Research, types of keywords, Analysis of keywords using Tools, easy to rank keywords, Analysis of Keyword, find Ranking Keyword of competitor, selecting right keywords, Top ranking Keywords of your sites, Find hidden ranking keywords of your website, LSI Keywords: Easy Strategies To find LSI Keywords, Content Research, Content Structure, Content Planning with Keywords, Internal links, Outbound link, Schema Markup.

UNIT 3: **11 lecture hours**

Negative SEO, avoid duplicate content on your website, Black hat SEO, Mistake by website owners,Bad practice on the website, Common Negative SEO practices, Defense against negative SEO, localSEO, Local SEO factors, Google My Business (GMB), optimize GMB Listing, Element's optimizationon GMB listing, Citations, citations in Local SEO.

UNIT 4: **8 lecture hours**

YouTube SEO Ranking Factors, Video Optimization, Title Optimization, Description Optimization, Thumbnail Optimization, Increase YouTube Subscribers Organically, SEO Strategy from Google Search Console & Google Analytics, maintain the position of existing ranking keywords, keep Eyes On Competitor Ranking Keywords.

Text Books:

1. *Das, S., Search Engine Optimization and Marketing: A Recipe for Success inDigital Marketing (1st ed.), CRC Press, 2021. ISBN 978-0367278786.*

Reference Books :

1. Clarke, A., SEO 2022: Learn Search EngineOptimization with Smart Internet Marketing Strategies (1st ed.), Simple Effectiveness LLC, 2022. ISBN 9780578333380,0578333384

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(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSO418	Digital Marketing	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1: Understand, visualize, and analyse online applications based on recent digital marketing trends.

CO2: Develop an in depth understanding of digital marketing and its applications.

CO3: To create a digital marketing plan, identifying digital channels, their advantages, and limitations, to perceiving ways of their integration taking into consideration the available budget.

Course Contents:

UNIT 1: **10 lecture hours**

Branding and Communications, Branding, Brand Engagement Strategy, Branding for International Markets, Marketing Communications, Marketing Data Identification and Collection, Marketing Data Integration and Exploratory Data Analysis, Predictive Analytics and Decision Making. Social Media and Content Marketing, Content Marketing Specialization, Paid Advertising and social media, Community Management, Marketing Communications, Campaign Planning, Developing creative communications. Public Relations.

UNIT 2: **11 lecture hours**

Search Engine Optimization (SEO), Search Engine Marketing (SEM), Keywords, On-Site SEO: Optimize UX & Design, Off-Site SEO: Link-building. Programmatic & Display Advertising, Search Engine Marketing with Google Ads (SEM), Keyword Selection, Create Text Ads, CPC Bidding, Navigate Google Ads, SEM Metrics & Optimization, Jobs in SEM, Display Advertising, Display Ads & Targeting, Sales Models, Display Ads in Google Ads, Video Advertising, Jobs in Display Advertising. Email Marketing, Email List Generation, Create an Effective Email Campaigns, Create an Email Plan, Measure Results, Measure & Optimize with Google Analytics Measurability, Understand Your Audience, Evaluate Acquisition, Understand Behavior, Evaluate Conversions, Optimize Campaign Budgets.

UNIT 3: **11 lecture hours**

Web Analytics, Robust Digital Marketing Strategy, designing a Web Presence, Social Media Marketing, Landscape, Channels, Content, Content Marketing, Implement & Monitor Campaigns, Measure Impact, Jobs in Social Media Marketing, Social Media Advertising, Platforms for Social Ads, Facebook, Facebook — Create Ad Sets, Facebook — Create and Manage Ads, Jobs in Social Media Advertising.

UNIT 4: **10 lecture hours**

Digital Marketing, Digital Marketing Framework, Digital Marketing Metrics and Channels, Customer Centricity, understanding your Business, your Customer, Marketing Channels, Marketing Objectives & KPIs, Content Strategy, Content planning, Content creation, Distribute & Promote Content, Optimize Website UX & Landing Pages, Measure Impact.

Text Book:

1. *McGruer, D, Dynamic Digital Marketing: Master the World of Onlineand Social Media Marketing to Grow Your Business (1st ed.), Wiley, 2020. ISBN 978 1119635888.*

Reference Books :

1. Kingsnorth, S, Digital Marketing Strategy: An Integrated Approach toOnline Marketing (2nd ed.), Kogan Page, 2019. ISBN 978-0749484224.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSO419	Advanced Skill Enhancement	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course-Outcomes (COs):

On completion of this course, the students will be able to:

CO1: Understand the latest trends, tools, technologies, and research in the field of computer science.

CO2: Implement the conceptual and practical understanding of the latest technologies and research trends related to the industry.

Course Contents:

UNIT 1: **42 lecture hours**

This course will help the students to explore their area of interest in depth and develop as well as nourish the skills required for the desirable job roles in the industry. The cutting-edge topics from different domains of computer science would be covered which will prepare the students for different job roles trending in the market and provide the students an edge over other candidates for the available job roles. Students will be performing lab work and projects to get real hands-on experience of the latest tools and technologies.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	Bachelor of Technology (Computer Science and Engineering)				
BCSO420	Advanced Industry Certification	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course-Outcomes (COs):

On completion of this course, the students will be able to:

CO1: Familiarize and learn about the latest trends, tools, technologies, and research in the field of computer science.

CO2: Develop the conceptual and practical understanding of the industry relevance of latest technologies and research trends.

Course Contents:

UNIT 1: **42 lecture hours**

This course covers the cutting-edge topics from different domains of computer science through relevant industry certifications which will prepare the students for different job roles trending in the market and help them gather the required skills that will provide the students an edge over other candidates for the available job roles. Students will be working on lab work and projects to get real hands-on experience of the latest tools and technologies. This course would be equivalent to two open elective courses.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	**Bachelor of Technology (Computer Science and Engineering)**				
BCSO421	**Global Experience and Practicum**	L	T	P	C
Owning School/Department	**Computer Science and Engineering**	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

On completion of this course, the students will be able to:

CO1. To provide students with the opportunity to gain an understanding of the global engineering landscape and develop practical skills through hands-on projects and industry-focused seminars.

CO2. To develop students' global competencies, including cross-cultural communication, problem-solving, and collaboration skills, to prepare them for success in a global engineering career.

Course Contents:

UNIT 1: **42 lecture hours**

This course will provide students with the opportunity to gain a global experience in the field of engineering. It will include an introduction to engineering principles, the design process, and the engineering process through a series of lectures, hands-on activities, and field trips. Students will apply their knowledge of engineering principles to work together to develop and design a project that will solve a global engineering challenge. The course will focus on using the scientific method to solve problems, discussing engineering ethics and safety regulations, and presenting their projects to their peers and instructors. They will also explore the impact of engineering on society and the environment and develop the skills necessary to successfully collaborate and innovate with their peers from different cultures. Upon completion of the course, students will have a well-rounded understanding of global engineering and the ability to apply their engineering knowledge in a global context.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

Name of Program	**Bachelor of Technology (Computer Science and Engineering)**				
BCSO422	**International Acquaintance and Externship**	L	T	P	C
Owning School/Department	**Computer Science and Engineering**	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

CO1. Acquire an appreciation and familiarity of the international computer science engineering professional network, as well as the current trends and developments in the industry.
CO2. Develop an understanding of the international technology landscape and how it impacts the field of computer science engineering.

Course Contents:

UNIT 1: **42 lecture hours**

This course is designed to provide students with an introduction to the international aspects of computer science. Students will be exposed to a variety of topics related to computer science, including computer networking, software engineering, artificial intelligence, data mining, and web development. The course will also cover the fundamentals of international relations, including international law, economic and social policy, and global trade. Additionally, students will have the opportunity to participate in an international externship, where they will gain hands-on experience in a computer science-related field. The course will also provide guidance and mentoring to help students develop the skills necessary to handle international assignments.

Laboratory:

Students will gain practical experience by using tools and technologies related International Acquaintance and Externship.

RAMA UNIVERSITY UTTAR PRADESH,
KANPUR

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Terminology and Abbreviation

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

(vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))

L-T-P	Lecture-Tutorial-Practical hours per week.
Credits	Calculated as per AICTE norms (1 credit per lecture/tutorial hour, 0.5 credits per practical hour)
HSC	Humanities and Social Sciences including Management Courses
BSC	Basic Science Courses
ESC	Engineering Science Courses
PCC	Professional Core Courses
PEC	Professional Elective Courses
OEC	Open Elective Courses
PRC	Project Work, Seminar, Internship Courses
MC	Mandatory Courses
OUC	Audit Cources
MOOC	As per page no 191 of AICTE Model Curriculum for UG Degree Course 2022 (8 Credit from Mode 4 (Online Mode) and rest credits using Mode 3 (Screen Mode))