Minutes of Meeting
Board of Study
Bachelor of Computer Application
(Computer Science & Engineering)

[Applicable w.e.f. Academic Session 2025-2026 till Revised]

FACULTY OF ENGINEERING & TECHNOLOGY
RAMA UNIVERSITY, UTTAR PRADESH, KANPUR

Website: www.ramauniversity.ac.in

Ref: RU/FET/CSE/BOS/2025/003 **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 Bachelor of Computer Application 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:

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 & Machine Learning
   b) Data Science & Analytics
   c) Cloud Computing and Full Stack Development

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/BCA/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/BCA/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/BCA/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/BCA/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/BCA/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/BCA/006**	**Course Bucket Structure under R-25** Students and faculty suggested increasing elective choices and introducing structured specialization options.	The committee took the decision to approve the following bucket structure under **R-25**: • **Specialization Core I & II Bucket – 08Courses** • **Specialization Elective Bucket – 36 Courses** • **Professional Elective Bucket – 68 Courses** • **Open Elective Bucket – 20 Courses**

4. 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.

5. **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.

6. 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.

7. **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.

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

Encl.: Recommended Curriculum attached for consideration and approval.

CC:

1. Registrar Office
2. Examination Controller

Program Educational Objectives

At Rama University Computer Science and Engineering program will prepare its graduates to:
PEO-1: Graduates would demonstrate analytical and design skills including the ability to generate creative solutions and foster team-oriented, professionalism through effective communication in their careers.

PEO-2: Graduates would expertise in successful careers based on their understanding of formal and practical methods of application development using the concept of computer programming languages and design principles in national and international level.

PEO-3: Graduates would pursue advanced education, research and development moreover other creative and innovative efforts in Computer Application, as well as other professional careers.

PEO-4: Graduates would implement their exhibiting critical thinking and problem solving skills in professional practices or tackle social, technical and business challenges.

PEO-5: Graduates would illustrate effective work conventionalities and be able to adapt as well as accept to the challenges of a dynamic job environment.

Program Specific Outcomes

PSO-1: To engage in professional development and to pursue post graduate education in the fields of Information Technology and Computer Applications.

PSO-2: To provide the students about computing principles and business practices in software solutions, outsourcing services, public and private sectors.

PSO-3: Analyze and synthesis computing systems through quantitative and qualitative techniques.

PSO-4: Accept cross cultural, social, professional, legal and ethical issues prevailing in local and global industry.

Program Outcomes:

The main outcomes of the BCA (CSE) program are given here. At the end of the program a student shall be able:

PO-1: Acquire Knowledge of mathematical foundations, computer application theory and algorithm principles in the design and modeling of computer based

system.

PO-2: Understand the basic concepts to identify, analyze, design and perform experiments for proficient interpretation of results and practices in the core of latest technologies.

PO-3: Demonstrate knowledge of interdisciplinary fields such as humanities and social sciences, and engage in social and cultural activities to create awareness and inspire innovative IT solutions with societal impact.

PO-4: Own Skills of observations and drawing logical inferences from the scientific experiments and develop application programs to meet the desired results including attainable constraints such as social, economic, environmental, functional, technological.

PO-5: Gain exposure in solve interpersonal, social issues, preventive, ethical hacking, forensic security technologies.

PO-6: Attain potential to participate in functions professionally in multi-disciplinary teams with positive attitude and an ability to tackle and interact the audiences.

PO-7: Earn caliber to design, analyze and development principles in the construction of complex hardware and software computer systems.

PO-8: Attain in-depth knowledge and sustained learning leading to futuristic trends, innovation & research to fulfill global interest.

PO-9: Exhibit clarity on both conceptual and application-oriented skills of Computing for higher studies in Post Graduate programs.

PO-10: Learn to design innovative solutions for solving real life business problems and addressing business development issues with a passion for quality competency and holistic approach.

PO-11: Implement document solutions to significant computational problems and apply mathematical and scientific reasoning to a variety of computational problems for the research in the computer application field

Chairperson

Signature: .....

Name: Dr. Indrajeet Gupta

Date:

Internal Members

Signature: 1.....

Name: Dr. Abhay Shukla

2.....

Name: Dr. Somendra Tripathi

3.....

Name: Dr Neeraj

External Members

Signature: 1.....

Name: Dr. Tapas Badal

2.....

Name: Dr. Vandana Dixit Kaushik

3.....

Name: Dr. Shubha Jain

Signature: 4.....

Name: Mr. Lokesh Mehra

5.....

Name: Mr. Talha Jawed

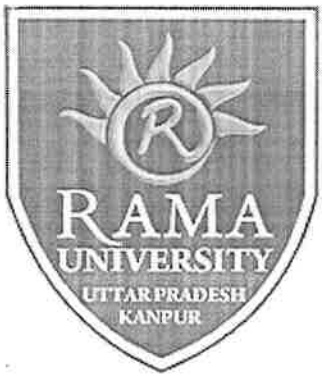
Date: 28.08.2025

ORDINANCE
For
Bachelor of Computer Applications

Program Code:

With Specialization in

Artificial Intelligence & Machine Learning (AIML)



Faculty of Engineering, Rama University

Preamble

The Bachelor of Computer Applications (BCA) with specialization in Artificial Intelligence and Machine Learning (AIML) programme at Rama University is designed to provide foundational knowledge, technical competence, and professional skills in the domain of computer science and its applications. This ordinance sets forth the academic framework, regulations, and standards governing the BCA programme with the objective of ensuring quality education, practical orientation, and the holistic development of students in consonance with the vision and mission of the University.

1. Program Name & Code

PROGRAM NAME: **BACHELOR OF COMPUTER APPLICATIONS with specialization in Artificial Intelligence and Machine Learning (AIML)**

PROGRAM CODE:

The Bachelor of Computer Applications (BCA) with specialization in Artificial Intelligence and Machine Learning (AIML) is an Undergraduate (UG) programme. It is offered in Rama University under the Faculty of Engineering.

2. Eligibility Criteria

Candidates who have successfully completed the 10+2 examination in any stream with a minimum of 50% marks from a recognized Board shall be eligible for admission.

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 total duration of the Bachelor of Computer Applications (B.C.A.) with specialization in Artificial Intelligence and Machine Learning (AIML) programme shall be three years, with each academic year comprising two semesters. Each semester shall ordinarily consist of ninety (90) working days of teaching, or such duration as may be prescribed by the UGC/ AICTE, and in alignment with the guidelines of the National Education Policy (NEP)-2020. The course of study shall be pursued through regular attendance in the prescribed number of lectures, tutorials, and practical training. The third and fifth semesters shall ordinarily be conducted from 1st July to 31st December, whereas the first semester shall ordinarily commence from 1st August. The remaining semesters shall ordinarily be conducted from 1st January to 30th June. These periods shall include

the time allotted for examinations and may be modified as deemed necessary and duly notified by the Vice- Chancellor or other competent authorities.

5. Maximum Duration for Completion

The maximum permissible duration for the completion of the BCA-AIML programme shall be six years, beyond which the candidate shall not be allowed to continue or be awarded the BCA-AIML degree.

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 Computer Applications (B.C.A.) with specialization in Artificial Intelligence and Machine Learning (AIML) programme is a three-year, six-semester undergraduate programme designed as per NEP-2020, UGC, and AICTE guidelines.

- **Core Courses:** Cover fundamental and advanced subjects in computer science and applications to build strong conceptual foundations.
- **Specialization Core (I and II):** Provide in-depth knowledge and skills in specific emerging domains.
- **Discipline-Specific Specialization Electives:** Offered in various areas such as Computer Science and Engineering, Artificial Intelligence and Machine Learning, Data Science & Analytics and Cloud Computing and Full Stack Development.
- **Professional Electives:** Enable students to gain advanced domain-specific expertise within the discipline.
- **Open Electives:** Promote interdisciplinary learning through courses offered by other faculties and departments.
- **Practical and Laboratory Courses:** Provide hands-on training aligned with theoretical subjects to enhance practical skills.
- **Project Work:** Develop research aptitude, problem-solving ability, and application of knowledge to real-world challenges.
- **Internships and Industrial Training:** Offer industry exposure, professional experience, and understanding of workplace practices.
- **Seminars, Workshops, and Viva Voce:** Improve communication, presentation, teamwork, and professional competencies.

8. Marks/Credit Distribution

The Bachelor of Computer Applications (BCA) with specialization in Artificial Intelligence and Machine Learning (AIML) programme spans six semesters over three

academic years. The structure progressively transitions from core theoretical foundations, laboratory work, and life-skill courses in the initial semesters to advanced specialization, professional electives, and interdisciplinary exposure in later semesters. The final year emphasizes project work, industrial training, and seminars/viva voce, thereby ensuring a balanced blend of conceptual knowledge, practical skills, and professional development in alignment with NEP-2020, UGC, and AICTE guidelines.

Semester	Course Type Included	Total Credits
I	Core Theory Courses + Core Labs + Life/Skill-Based Course	21
II	Core Theory + Labs + Life Skill Development Course	23
III	Core Theory + Advanced Core Labs + Discipline-Specific Electives + Lab	25
IV	Advanced Core + Specialization Core / Professional Electives + Open Elective + Lab	21
V	Discipline-Specific Electives + Professional Electives or Professional Practical Internship + Open Elective	18
VI	Capstone Project/ Project Semester at Industry/ Startup Project	12
Total		**120**

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),

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.

Seminar/Project: Lean Startups (3rd Semester)

- **Marks Distribution:** CA – 30, MTE – 20, ETE – 50 (Total = 100 Marks)
- **Assessment:**
  - Continuous assessment based on presentations, participation, and innovation in startup/project ideas.
  - Mid-term evaluation by internal faculty to review project progress.
  - End-term evaluation through seminar/viva-voce presentation before an internal board.
- **Guidelines:**
  - Each student must prepare and present a seminar/project report on a Lean Startup theme under faculty supervision.
  - Emphasis is placed on innovation, feasibility, and practical application.
  - Evaluation criteria include originality, clarity of presentation, quality of documentation, and ability to defend ideas.

Capstone Project (5th Semester)

- **Marks Distribution:** CA – 30, MTE – 20, ETE – 50 (Total = 100 Marks)
- **Assessment:**
  - Continuous assessment based on project reports, coding implementation, and periodic presentations.
  - Mid-term evaluation conducted by a project review committee.
  - End-term evaluation based on project demonstration, report submission, and viva-voce.
- **Guidelines:**
  - Students shall undertake the capstone project individually or in small groups under the supervision of a faculty guide.
  - The project should integrate knowledge gained across courses and demonstrate problem-solving ability.
  - Evaluation will consider technical depth, methodology, quality of implementation, and presentation.

Dissertation/Internship/Industry Project (6th Semester)

- **Marks Distribution:** CA – 100, MTE – 100, ETE – 300 (Total = 500 Marks)
- **Assessment:**
  - Continuous Assessment (CA): Based on progress reports, project milestones, and interaction with the guide.
  - Mid-Term Evaluation (MTE): Conducted by a departmental review committee to assess the progress and technical depth of the project.

- End-Term Evaluation (ETE): Conducted by a board of internal and external examiners appointed by the Dean, based on report submission, seminar, and viva-voce.

- **Guidelines:**
  1. Students shall carry out dissertation/project work in an industry, research laboratory, or approved academic setting under a supervisor nominated by the Dean.
  2. A minimum of four hard copies of the final dissertation report, along with one soft copy, must be submitted at least two weeks before the term-end examination.
  3. Evaluation criteria include:
     - Problem identification and objectives.
     - Methodology, technical depth, and use of tools/technologies.
     - Originality, innovation, and contribution to research/industry.
     - Quality of report writing, formatting, and referencing.
     - Seminar/viva-voce presentation and defense.

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:

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

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	-
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 shall be required to complete the courses and activities as specified in schema/syllabus. Further, the programme mandates participation in co-curricular and professional development components, including a Seminar/Project on *Lean Startups,* industrial visits during the programme, a professional practical internship of 4–6 weeks in V semester(optional), a Capstone Project/ Project Semester at Industry/ Startup Project during the last semester. Students must also undertake seminar and viva voce presentations as integral elements of the assessment framework.

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): **Advance Certificate in respective specialization**
- After 3 years (6 semesters): **Bachelor 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

BCA (AIML/DSA/CCFSD)

I SEM

S No	Course Code	Course Name	L	T	P	CREDITS	CA	MTE	ETE	TOTAL MARKS
1	BCA1001	Digital Design and Computer Organization	2	0	0	2	30	20	50	100
2	BCA1002	Computational Thinking with Python	2	1	0	3	30	20	50	100
3	BCA1003	Web Technologies	2	0	0	2	30	20	50	100
4	BCA1004	New Age Life Skills	2	0	0	2	30	20	50	100
5	BCA1005	Mathematics Foundations	3	1	0	4	30	20	50	100
6	BCA1006	Environment and Sustainability	2	0	0	2	30	20	50	100
7	BCA1051	Digital Design and Computer Organization Lab	0	0	2	1	30	20	50	100
8	BCA1052	Computational Thinking with Python Lab	0	0	6	3	30	20	50	100
9	BCA1053	Web Technologies Lab	0	0	4	2	30	20	50	100
		Total	**13**	**2**	**10**	**21**				**900**
	ICIE101	Introduction to Innovation and Entrepreneurship	1	1	0	0			50	-
		Total Up to 1st Semester								
		*ICIE101 will be run as a mandatory Pass/Fail course.								

II SEM

S No	Course Code	Course Name	L	T	P	CREDITS	CA	MTE	ETE	TOTAL MARKS
1	BCA2001	Fundamentals of Microprocessors and Computer Architecture	2	0	0	2	30	20	50	100
2	BCA2002	C Programming	2	0	0	2	30	20	50	100
3	BCA2003	Data Structures: Concepts and Practice	3	1	0	4	30	20	50	100
4	BCA2004	Information Management System Development	3	0	0	3	30	20	50	100
5	BCA2005	System and Software Development Life Cycle	2	0	0	2	30	20	50	100
6	BCA2006	Mathematics for Computer Applications	3	1	0	4	30	20	50	100
7	BCA2007	Social Activity (General Interest/ Sports / NCC/ NSS) During Summer	0	0	0	1	30	20	50	100
8	BCA2051	Fundamentals of Microprocessors and Computer Architecture Lab	0	0	2	1	30	20	50	100
9	BCA2052	C Programming Lab	0	0	2	1	30	20	50	100
10	BCA2053	Data Structures: Concepts and Practice Lab	0	0	2	1	30	20	50	100
11	BCA2054	Information Management System Development Lab	0	0	2	1	30	20	50	100
12	BCA2055	System and Software Development Life Cycle Lab	0	0	2	1	30	20	50	100
		Total	**15**	**2**	**10**	**23**				**1200**
		Total Up to 2nd Semester								

III SEM										
S No	**Course Code**	**Course Name**	**L**	**T**	**P**	**CREDITS**	**CA**	**MTE**	**ETE**	**TOTAL MARKS**
1	BCA3001	Principles of Object Oriented Programming using Java	3	0	0	3	30	20	50	100
2	BCA3002	Operating System Concepts	2	0	0	2	30	20	50	100
3	BCA3003	Algorithm Design Strategies	3	1	0	4	30	20	50	100
4	BCA3004	Economics and Business Perspective of IT Projects	2	0	0	2	30	20	50	100
5	BCA3005	Ethics for Professionals, Patents, Copyrights and IPR	1	0	0	1	30	20	50	100
6	BCA3101-BCA3104 /BCA3006	Specialization Core-I/ UI UX Design	3	0	0	3	30	20	50	100
7	BCAP301-BCAP368	Professional Elective-I	3	0	0	3	30	20	50	100
8	BCA3051	Principles of Object Oriented Programming using Java Lab	0	0	4	2	30	20	50	100
9	BCA3052	Operating System Concepts Lab	0	0	2	1	30	20	50	100
10	BCA3053	Algorithm Design Strategies Lab	0	0	6	3	30	20	50	100
11	BCA3151-BCA3154 /BCA3056	Specialization Core -I Lab / UI UX Design Lab	0	0	2	1	30	20	50	100
		Total	**17**	**1**	**14**	**25**				**1100**
		Total Up to 3rd Semester								
IV SEM										
S No	**Course Code**	**Course Name**	**L**	**T**	**P**	**CREDITS**	**CA**	**MTE**	**ETE**	**TOTAL MARKS**
1	BCA4001	Network Essentials	2	0	0	2	30	20	50	100
2	BCA4002	Seminar on Special topics in Computer Applications	0	1	0	1	30	20	50	100
3	BCA4003	Mobile Programming	2	0	0	2	30	20	50	100
4	BCA4101-BCA4104 /BCA4004	Specialization Core-II /Introduction to Cloud Computing	3	0	0	3	30	20	50	100
5	BCAS401-BCAS433	Specialization Elective-I	3	0	0	3	30	20	50	100
6	BCAO401-BCAO420	Open Elective-I	3	0	0	3	30	20	50	100
7	BCA4051	Network Essentials Lab	0	0	2	1	30	20	50	100
8	BCA4053	Mobile Programming Lab	0	0	2	1	30	20	50	100
9	BCA4054	Solving Problems with Design Thinking and Innovation Lab	0	0	4	2	30	20	50	100
10	BCA4055	Competitive Programming Skills Lab	0	0	4	2	30	20	50	100
11	BCA4151-BCA4154 /BCA4054	Specialization Core -II Lab/Introduction to Cloud Computing Lab	0	0	2	1	30	20	50	100
		Total	**13**	**1**	**14**	**21**				**1100**
		Total Up to 4th Semester								
V SEM										
S No	**Course Code**	**Course Name**	L	T	P	**CREDITS**	**CA**	**MTE**	**ETE**	**TOTAL MARKS**
1	BCAS401-BCAS433	Specialization Elective - II	3	0	0	3	30	20	50	100
2	BCAP301-BCAP368	Professional Elective-II	3	0	0	3	30	20	50	100
3	BCAO401-BCAO420	Open Elective - 2	3	0	0	3	30	20	50	100

4	BCA5051	Capstone Project	0	0	18	9	30	20	50	100
		Total	9	0	18	18				**400**
		Total Up to 5th Semester								
		Or								
1	BCA5052	Professional Practical Internship	0	0	36	18	100	100	200	**400**
		Total Up to 5th Semester				**108**				

VI SEM

S No	Course Code	Course Name	L	T	P	CREDITS	CA	MTE	ETE	TOTAL MARKS
1	BCA6051	Capstone Project/ Project Semester at Industry/ Startup Project	0	0	24	12	200	100	200	500
		Total	**0**	**0**	**24**	**12**				**500**
		Total Up to 6th Semester								

Specialization Core I

S No	Course Code	Course Name	L	T	P	CREDITS	Specilization
1	BCA3101	Full Stack Development	3	0	2	4	Full Stack: Specialization Core I
2	BCA3102	Data Analysis using Python	3	0	2	4	Data Science & Analytics Specialization Core I
3	BCA3103	Cloud Computing Foundation	3	0	2	4	Cloud Computing: Specialization Core I
4	BCA3104	Statistical Machine Learning	3	0	2	4	AI & ML Specialization Core I
5	BCA3151	Full Stack Development Lab	0	0	2	1	Full Stack: Specialization Core I
6	BCA3152	Data Analysis using Python Lab	0	0	2	1	Data Science & Analytics Specialization Core I
7	BCA3153	Cloud Computing Foundation Lab	0	0	2	1	Cloud Computing: Specialization Core I
8	BCA3154	Statistical Machine Learning Lab	0	0	2	1	AI & ML Specialization Core I

Specialization Core II

S No	Course Code	Course Name	L	T	P	CREDITS	Specilization
1	BCA4101	Programming Methodologies for Backend Development	3	0	2	4	Full Stack: Specialization Core II
2	BCA4102	Data Mining and Predictive Modelling	3	0	2	4	Data Science & Analytics Specialization Core II
3	BCA4103	Cloud Architectural Solution	3	0	2	4	Cloud Computing: Specialization Core II
4	BCA4104	Intelligent Model Design using AI	3	0	2	4	AI & ML Specialization Core II
5	BCA4151	Programming Methodologies for Backend Development Lab	0	0	2	1	Full Stack: Specialization Core II
6	BCA4152	Data Mining and Predictive Modelling Lab	0	0	2	1	Data Science & Analytics Specialization Core II
7	BCA4153	Cloud Architectural Solution Lab	0	0	2	1	Cloud Computing: Specialization Core II
8	BCA4154	Intelligent Model Design using AI Lab	0	0	2	1	AI & ML Specialization Core II

Specialization Electives I: Artificial Intelligence

S No	Course Code	Course Name	L	T	P	C
1	BCAS401	Advanced Computer Vision and Video Analytics	3	0	0	3
2	BCAS402	Cognitive Modelling	3	0	0	3
3	BCAS403	AI in Healthcare	3	0	0	3
4	BCAS404	Image and Video Processing	3	0	0	3

5	BCAS405	Information Retrieval and Search Engine	3	0	0	3
Specialization Electives II: Artificial Intelligence						
S No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	BCAS406	Natural Language Processing	3	0	0	3
2	BCAS407	Probability and Random Processes	3	0	0	3
3	BCAS408	Reinforcement Learning	3	0	0	3
4	BCAS409	Special Topics in Artificial Intelligence	3	0	0	3
Specialization Electives I : Cloud Computing						
S No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	BCAS410	Cloud Services Development and Operations	3	0	0	3
2	BCAS411	Cloud System Administration and Operations	3	0	0	3
3	BCAS412	Cloud Security and Compliances	3	0	0	3
4	BCAS413	AWS Cloud Support Associate	3	0	0	3
Specialization Electives I : Cloud Computing						
S No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	BCAS414	Developing Solutions for Microsoft Azure	3	0	0	3
2	BCAS415	Cloud Infrastructure and Services	3	0	0	3
3	BCAS416	Software Containerization in DevOps	3	0	0	3
4	BCAS417	Special Topics in Cloud Computing	3	0	0	3
Specialization Electives I : Data Science & Analytics						
S No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	BCAS418	Digital Marketing and Trend Analysis	3	0	0	3
2	BCAS419	Structural Equation Modelling	3	0	0	3
3	BCAS420	Time Series Analysis	3	0	0	3
4	BCAS421	Data Visualization and Dashboards	3	0	0	3
5	BCAS422	Social Network Analysis	3	0	0	3
Specialization Electives II : Data Science & Analytics						
S No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	BCAS423	Big Data Analytics and Business Intelligence	3	0	0	3
2	BCAS424	Advanced Database Management System	3	0	0	3
3	BCAS425	Satellite Data Analysis	3	0	0	3
4	BCAS426	Security and Privacy for Big Data Analytics	3	0	0	3
5	BCAS427	Special Topics in Data Science	3	0	0	3
Specialization Electives I : Full Stack						
S No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	BCAS428	Front-End UI Frameworks and Tools: Flutter and Django	3	0	0	3
2	BCAS429	Front-End Web UI Frameworks and Tools: React Native	3	0	0	3
3	BCAS430	Front-End Web UI Frameworks and Tools: Bootstrap	3	0	0	3

Specialization Electives II : Full Stack						
S No	Course Code	Course Name	L	T	P	C
4	BCAS431	Server-Side Development Frameworks: Express and Spring	3	0	0	3
5	BCAS432	Web Development for Blockchain Applications	3	0	0	3
6	BCAS433	Special Topics in Full Stack	3	0	0	3

Professional Electives I						
S No	Course Code	Course Name	L	T	P	C
1	BCAP301	User Centered Design	3	0	0	3
2	BCAP302	Secure Coding	3	0	0	3
3	BCAP303	Compiler Construction	3	0	0	3
4	BCAP304	Software Project Management	3	0	0	3
5	BCAP305	Soft Computing	3	0	0	3
6	BCAP306	Distributed Computing	3	0	0	3
7	BCAP307	Agile Software Development	3	0	0	3
8	BCAP308	Virtual Reality: Interface, Application and Design	3	0	0	3
9	BCAP309	Combinatorics	3	0	0	3
10	BCAP310	Mobile and Networked Embedded Systems	3	0	0	3
11	BCAP311	Problem Solving using C	3	0	0	3
12	BCAP312	Programming using C++	3	0	0	3
13	BCAP313	Deep Learning	3	0	0	3
14	BCAP314	Bioinformatics and Computational Genomics	3	0	0	3
15	BCAP315	Special Topics in Computer Science	3	0	0	3
16	BCAP316	Advanced Microprocessor	3	0	0	3
17	BCAP317	IoT: Security and Attacks	3	0	0	3
18	BCAP318	Blockchain Technologies: Platforms & Applications	3	0	0	3
19	BCAP319	Smart Contracts and Solidity Programming	3	0	0	3
20	BCAP320	Digital Currencies and Blockchain	3	0	0	3
21	BCAP321	Blockchain Policy: Legal, Social and Economic Impact	3	0	0	3
22	BCAP322	Cyber Security with Blockchain	3	0	0	3
23	BCAP323	Modern Cryptography	3	0	0	3
24	BCAP324	Special Topics in Blockchain	3	0	0	3
25	BCAP325	Google Associate Cloud Engineer	3	0	0	3
26	BCAP326	Malware Analysis for Mobile Devices	3	0	0	3
27	BCAP327	Device Level IoT Security	3	0	0	3
28	BCAP328	Vulnerability Analysis in Network Protocols	3	0	0	3
29	BCAP329	Penetration Testing, Auditing and Ethical Hacking	3	0	0	3
30	BCAP330	Forensics and Cyber Law	3	0	0	3
31	BCAP331	Web Security	3	0	0	3
32	BCAP332	Special Topics in Information Security	3	0	0	3
33	BCAP333	Build and Release Management in DevOps	3	0	0	3

34	BCAP334	Continuous Integration and Deployment in DevOps	3	0	0	3
Professional Electives II						
S No	Course Code	Course Name	L	T	P	C
1	BCAP335	Software Craftsmanship in DevOps	3	0	0	3
2	BCAP336	System Provisioning and Configuration Management in DevOps	3	0	0	3
3	BCAP337	Test Automation in DevOps	3	0	0	3
4	BCAP338	Source and Version Control in DevOps	3	0	0	3
5	BCAP339	Special Topics in DevOps	3	0	0	3
6	BCAP340	Auto Pilot and Flight Control	3	0	0	3
7	BCAP341	Drone Communication	3	0	0	3
8	BCAP342	UAV Mission Planning and Deployments	3	0	0	3
9	BCAP343	UAV Simulation	3	0	0	3
10	BCAP344	Drone Swarming	3	0	0	3
11	BCAP345	Drone Applications, Components and Assembly	3	0	0	3
12	BCAP346	Special Topics in Drone Technology	3	0	0	3
13	BCAP347	Server-Side Development Frameworks: Express and Spring	3	0	0	3
14	BCAP348	VR Gaming	3	0	0	3
15	BCAP349	Augmented Reality	3	0	0	3
16	BCAP350	Game Mechanics and Game Physics	3	0	0	3
17	BCAP351	Game Programming with HTML5	3	0	0	3
18	BCAP352	AI for Games	3	0	0	3
19	BCAP353	Animation and Rendering Techniques	3	0	0	3
20	BCAP354	Pixel and Poly Arts for Games	3	0	0	3
21	BCAP355	Game Design, Development and Programming	3	0	0	3
22	BCAP356	Special Topics in Gaming	3	0	0	3
23	BCAP357	Android Application using Kotlin	3	0	0	3
24	BCAP358	Modern and Contemporary Application in CS	3	0	0	3
25	BCAP359	Latest Advances in Engineering and Technology	3	0	0	3
26	BCAP360	Emerging Topics in Artificial Intelligence	3	0	0	3
27	BCAP361	Emerging Topics in Blockchain	3	0	0	3
28	BCAP362	Emerging Topics in Cloud Computing	3	0	0	3
29	BCAP363	Emerging Topics in Cyber Security	3	0	0	3
30	BCAP364	Emerging Topics in Data Science	3	0	0	3
31	BCAP365	Emerging Topics in DevOps	3	0	0	3
32	BCAP366	Emerging Topics in Full Stack	3	0	0	3
33	BCAP367	Emerging Topics in Gaming	3	0	0	3
34	BCAP368	Emerging Topics in Mobile Technologies	3	0	0	3
Open Electives I						
S No	Course Code	Course Name	L	T	P	C
1	BCAO401	Applications of AI	3	0	0	3

2	BCAO402	Semantic Technology	3	0	0	3
3	BCAO403	IT Support Technologies	3	0	0	3
4	BCAO404	Software Engineering	3	0	0	3
5	BCAO405	Programming Languages	3	0	0	3
6	BCAO406	Artificial Intelligence for Creative Expression	3	0	0	3
7	BCAO407	AI and Public Policy	3	0	0	3
8	BCAO408	Linux Apache MySQL PHP (LAMP)	3	0	0	3
9	BCAO409	Data Structures and Algorithms	3	0	0	3
10	BCAO410	Software Testing	3	0	0	3

Open Electives II

S No	Course Code	Course Name	L	T	P	C
1	BCAO411	Computing Start-ups	3	0	0	3
2	BCAO412	Cyber security: Impact on Govts, Policies and Economics	3	0	0	3
3	BCAO413	AI and Society	3	0	0	3
4	BCAO414	Search Engine Optimization	3	0	0	3
5	BCAO415	Growth Hacking	3	0	0	3
6	BCAO416	Digital Marketing	3	0	0	3
7	BCAO417	Advanced Skill Enhancement	3	0	0	3
8	BCAO418	Advanced Industry Certification	3	0	0	3
9	BCAO419	Global Experience and Practicum	3	0	0	3
10	BCAO420	International Acquaintance and Externship	3	0	0	3

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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))

Bachelor of Computer Applications (BCA): 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 Computer Applications				
BCA1001/ BCA1051	Digital Design and Computer Organization	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: Identify appropriate truth table and examine gate level implementation from combinational logic function.
CO2: Design sequential circuits.
CO3: Demonstrate hands-on experience on implementing different data structures

Course Contents:

UNIT 1: **11 lecture hours**

Introduction to Digital Logic: Importance of Digital Logic, Distinctions between Analog and Digital Systems, Fundamentals of Data Representation in Digital Systems : Binary Number System, Decimal Number System, Octal Number System, Hexa-Decimal Number System, Binary Arithmetic: Basic Arithmetic Operations in Unsigned and Signed Numbers, Signed Magnitude, 1's Complement, 2's Complement, Fixed- and Floating-Point Numbers, Weighted Codes, BCD Code, Basic Logic Gates, Building Blocks of Digital Logic, Universal Logic Gates, Truth Table, Laws of Boolean Algebra, Reduction of Boolean Expression using Boolean Laws, Conversion of Boolean Expression to Logic Diagram, Conversion of Logic Diagram to Boolean Expression, Techniques for Reducing Boolean Expressions: SoP and PoS form, Standard Sum of Products, Standard Product of Sum, Two Variable K-Map, Three Variable K-Map, Don't Care Condition, Excess-3, Gray Code: Overview and Application in Digital Systems.

UNIT 2: **7 lecture hours**

Combinational Circuits Overview,: Half Adder, Full Adder and Carry Propagation, Subtractor, Four Bit Binary Adder-Subtractor, Binary Multiplier, Magnitude Comparator, Multiplexer, De-Multiplexer, 2 to 4 Decoder, 4 * 2 Encoder, Priority Encoder, BCD to 7-segment Display Decoder.

UNIT 3: **10 lecture hours**

Introduction to Sequential Circuits:Distinction Between Sequential and Combinational Circuits, Clocking in Digital Systems: Understanding the Significance of Clocks, Clocking Mechanisms in Sequential Circuits Flip Flop: SR Flip Flop Circuit Diagram, SR Flip Flop Truth Table, SR Flip Flop Characteristic Table, SR Flip Flop Excitation Table, JK Flip Flop Circuit Diagram, JK Flip Flop Truth Table, JK Flip Flop Characteristic Table, JK Flip Flop Excitation Table, Race Around Condition, Master Slave JK Flip Flop, D Flip Flop, T Flip Plop, Registers in Digital Systems: Parallel Register, Shift Registers, Bi-Directional Shift Register, Universal Shift Register, Counter, Asynchronous v/s Synchronous Counter, Ripple Counter (UP, DOWN, UP/DOWN).

Laboratory:

Installation of HDL (Verilog), Syntax, Compilation and Validation Walk through, Implementation of Logic Gates, Implementation of Combinational Circuits using structural and behavioural Verilog coding, Conversion of Logic Gates using Universal Gate representation, Develop Half Adder, Full Adder and Subtractor in Verilog HDL, Use the Half Adder Module to construct Full Adder, Use the Full Adder module

to construct ripple carry adder, Implement Decoder, Encoder and Priority Encoder in Verilog HDL, Implement Multiplexer and De-Multiplexer in Verilog HDL, Lab Assessment 1, Implement D Latch using Verilog, Implement D Flip Flop using the latch, Simulate the Operations of SR and JK Flip Flop using SR Latch, 16 Bit Up-Down Synchronous Counter using Verilog, 16 Bit Ripple Asynchronous Counter using Verilog.

Text Book:

1. *M. Morris Mano, Digital Design. with an Introduction to the Verilog HDL (5th ed.), Pearson, 2014. ISBN 978-9332535763.*
2. Wakerley and John, Digital Design: Principles and Practice (5th ed.), Prentice Hall, 2017. ISBN 9780134460093

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Name of Program	Bachelor of Computer Applications				
BCA1002/ BCA1052	Computational Thinking with Python	L	T	P	C
Owning School/Department	Computer Science and Engineering	2	1	6	6
Pre-requisites/Exposure	-				

Course Outcomes (COs)

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

CO1: Solve given problem in Python by using standard programming constructs.
CO2: Build programs using the features of object-oriented programming languages.
CO3: Make use of Python inbuilt API's to solve given problem.

Course Contents:

UNIT 1: **8 lecture hours**

Introduction to Python, Why python? Python in Action: Applications and Use Cases, versions of python,Exploring Number Systems: binary, octal, Literals/Variables, Data Types, Harnessing the Power of Operators in Python, Control Structures (if/else), if/else/elif, Nested if/else, Lists/Nested Lists, Python's Dynamic Arrays, Tapping into Tuple Power in Python.

UNIT 2: **10 lecture hours**

Loop Control Structure: Iterative Control, While loop, For loop, Range, Break, Continue, Pass, Nested Loops,List structure: List Operations, List comprehension, Operators: Membership operator, Functions, Default argument, required arguments, keyword argument, variable arguments, Functions in Python:: Function invoking, Nested functions, Lambda functions, Map Reduce, Recursive Functions, Calculating Factorials and GCD Using Euclid's Algorithm Dictionary Operations, Sets, Enumerators.

UNIT 3: **10 lecture hours**

String Operations, Slicing, File Handling, Exception Handling, Modules, Navigating Namespaces: Local, Global, and Built-in Namespaces, Dive into Object-Oriented Programming: Classes and Objects, Encapsulation, Data abstraction, Inheritance, Polymorphism, Visual Delights in Python : Interactive Graphics, Displaying Images, Generating Colors, Graphics Objects, Entry Objects, Turtle, Working with Widgets, Controlling Layout with Geometry Managers, Events and Event Handlers,. Developing Interactive Applications: A Hands-On Approach.

Laboratory:

The lab component of this course is designed to introduce online-coding tools to the students and provide hands-on experience with the concepts taught in the lectures.

Text Book:

1. *Dierbach, Introduction to Computer Science Using PYTHON: A Computational Problem-Solving Focus (15th ed.), Wiley, 2015. ISBN 978-81-265-5601-4.*
2. Martinez, D.and Jesús, S. D., Applied Computational Thinking with Python: Design Algorithmic Solutions for Complex and Challenging Real-world Problems. (n.p.) (1st ed.), Packt Publishing, 2020. ISBN 9781839216763.

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Name of Program	Bachelor of Computer Applications				
BCA1003/ BCA1053	Web Technologies	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: Utilize the set of standards, protocols, and interfaces required to deliver information reliably and efficiently over the Internet.
CO2: Use of hypertext mark-up languages and multimedia packages, using which computers communicate with each other.
CO3: Create web pages (websites) or applications that run in a web browser.

Course Contents:

UNIT 1: **9 lecture hours**

Fundamentals of Internet and Web, Internet Communication, Domains, Internet Server, Establishing connection on the Internet, Client IP Address, Understanding 3-Tier web architecture, A Brief Overview of OSI and TCP/IP models, Web Server, Web browser, Domain Registration, Web site, Static, Dynamic and Active web page, Simple Mail Transfer Protocol, Gopher, Telnet, Emails, TFTP, Simple Network Management Protocol, Hyper Text Transfer Protocol, Client server computing concepts, Introduction to HTML, Essential Tags, Commonly Used HTML Commands, Title and Footers, Text Formatting, Style, Lists, Graphics incorporation to HTML Documents, Linking Documents, Frames, Hypertext, Hyperlink and Hypermedia, Links, Anchors and URLs, Links to External Documents, Different Section of a Page and Graphics, Footnote and e-mailing, Creating Table, Frame, Form.

UNIT 2: **9 lecture hours**

Cascading Style Sheets, Syntax, Class Selector, Id Selector DOM (Document Object Model), DSO (Data Source Object, Approaches to Dynamic Pages, CGI, Java Applets, Plug Ins, Active X, Java Script Object Model, Variables, Constant, Data Types, Expressions, Conditions-Relational Operators, Flow Control, Functions & Objects-events and event handlers, Data type Conversion & Equality, Accessing HTML form elements, Introduction to PHP, Variables, Data types, Type Casting, Operators and its Precedence, References, Arrays, Control Structures, Loop, User Defined Functions, Built-in Functions, Functions for Variables, Script, Controlling Functions, Date and time Functions, Mathematical Functions, String Functions.

UNIT 3: **10 lecture hours**

PHP Server Variables, Working with form, Uploading files to Web Server using PHP, Basic command of databases with PHP, XML Schema Standards, Linking & Presentation Standards, Generating XML data, Writing a simple XML File, Creating a Document type definition, Documents & Data, Defining Attributes & Entities in the DTD, Defining Parameter Entities & conditional Sections, Resolving a naming conflict, Using Namespaces, Designing an XML data structure, Normalizing Data, Web Page Lay-Outing, Where to Host Site, Maintenance of Site, Registration of Site on Search Engines and Indexes, Introduction to File Transfer Protocol, Public Domain Software, Types of FTP Servers (Including Anonymous), FTP Clients Common Command, Telnet Protocol, Server Domain, Telnet Client, Terminal Emulation, Usenet And Internet Relay Chat.

Laboratory:

Basic HTML Tags, Table, List, Image, Forms Implementation of forms using HTML, FRAMES, CSS, Embedding of audio and video into HTML page, Creation of an XHTML document that illustrates the use of external style sheet, ordered list, table, borders, padding, color, and the tag. Create a webpage with HTML describing your department use paragraph and list tags, apply various colors to suitably distinguish key words, also apply font styling like italics, underline and two other fonts to words you find appropriate, also use header tags, Creation of text hyperlink to reach external web pages, Insert an image and create a link such that clicking on image takes user to other page, Change the background color of the page; At the bottom create a link to take user to the top of the page, To develop and demonstrate a XHTML file that includes JavaScript script for the following problems: Input: A number n obtained using prompt, Output: The first n prime numbers, Input: A number n obtained using prompt, Output: A table of numbers from 1 to n and their squares using alert. To develop and demonstrate a XHTML file that includes Javascript script that uses functions for the following problems: Parameter: A string, Output: Reverse the string. Parameter: A number, Output: The number with its digits in the reverse order. To develop and demonstrate, using Javascript, a XHTML document that collects the RollNo (the valid format is: two upper-case characters followed by two digits followed by two upper-case characters followed by three digits; no embedded spaces allowed- e.g. AB23CD356, GC13CS345) of the user. Event handler must be included for the form element that collects this information to validate the input. Messages in the alert windows must be produced when errors are detected. To Modify the above program to get the current semester also (restricted to be a number from 1 to 6).

Text Book:

1. *C. Xavier, Web Technology and Design (1st ed.), NEW AGE, 2018. ISBN 9788122414509.*
2. Robertw and Sebesta,, Programming World Wide Web (8th ed.), Pearson Education, 2020. ISBN 978-9353946142.

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Name of Program	Bachelor of Computer Applications				
BCA1004	New Age Life Skills	L	T	P	C
Owning School/Department	Computer Science and Engineering	2	0	0	2
Pre-requisites/Exposure	-				

Course Outcomes (COs)

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

CO1: By the end of this course, students should be able to express their role in improving their quality of life.
CO2: By the end of this course, students should be able to understand human psychology and its applications to improve human achievements and happiness to substantial extent.
CO3: By the end of this course, students should be able to reflect on the aspects of leadership, motivation and stress management.
CO4: By the end of this course, students should be able to appreciate the nature of positive and proactive thinking and assertiveness.
CO5: By the end of this course, students should be able to apply concepts, tools and frameworks of emotional intelligence and stress management.

Course Contents:

UNIT 1: **8 lecture hours**
Exploring the Fundamentals of Life Skills and Self-Discovery, Recognizing the Significance of Critical Thinking and Assertive Communication, Unleashing the Power of Effective Time Management and Goal Setting Strategies

UNIT 2: **8 lecture hours**
Navigating Challenges Through Analytical and Creative Problem-Solving Approaches, Understanding the Dynamics of Attitude and Personality Development, Maximizing Productivity through Effective Collaboration in Work Groups and Teams.

UNIT 3: **6 lecture hours**
Mastering the Essentials of Communicating Effectively in Personal and Professional Settings, Gaining Insights into Power Dynamics, Building Influence, and Motivating Others.

UNIT 4: **6 lecture hours**
Developing Skills for Managing and Resolving Conflicts Constructively, Fostering Empowerment and Effective Delegation in Professional Environments

Text Book:

1. *David A. Whetten and Kim S. Cameron, Developing Management Skills (8th ed.), Pearson, 2017. ISBN 9789332584686, 9332584680.*
2. Alka Wadkar, Life Skills for Success (1st ed.), Sage Publications, 2016. ISBN 9789351507314,9351507319.

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Name of Program	Bachelor of Computer Applications				
BCA1005	Mathematics Foundations	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: Understand the concept of sets and functions, proofing method, mathematical Induction.
CO2: Understand the basic counting principles; permutations and combinations.
CO3: Apply the statistical measures and concept of the probability.

Course Contents:

UNIT 1: **14 lecture hours**

Concept of matrix, Notation, Order and Equality, Types of matrices, Transpose of a matrix, Symmetric and skew symmetric matrices, Addition, Multiplication and scalar multiplication of matrices, Properties of matrix addition and multiplications, Determinant of a square matrix, Cramer's rule, Properties of determinants, Adjoint and inverse of a square matrix, Concept of elementary row and column operations, Invertible matrices, Consistency, inconsistency, and number of solutions of system of linear equations by examples, Solving system of linear equations in two or three variables using inverse of a matrix, Characteristic equation, Eigen value and eigen vectors, Singular value decomposition, Mathematical Induction, Principle of Mathematical Induction & Theorems, Applications of Mathematical Induction.

UNIT 2: **14 lecture hours**

Sets, relations, and functions, Sets and their representations, Empty set, Finite & Infinite sets, Equal sets, Subsets, Power set, Universal set, Venn diagrams, Union and Intersection of sets, Difference of sets, Complement of a set, Types of functions – Definitions, Inverse functions, Fundamental Principle of counting, Sum and product rule, The principle of inclusion-exclusion, Permutation definition, Linear and circular permutations, Permutations of 'n' dissimilar things taken 'r' at a time, Permutations when repetitions allowed, Circular permutations, Permutations with constraint repetitions, Combinations, Combination with repetition, Combination without repetition, Ordered and unordered partitions, Binomial coefficients and properties, The binomial and multinomial theorem and applications.

UNIT 3: **14 lecture hours**

Probability and Statistics, Measure of dispersion, Mean, median, mode, Range, mean deviation variance of ungrouped/grouped data, standard deviation of ungrouped/grouped data, Coefficient of variation, Analysis of frequency distribution with equal means but different variances, Random experiments: outcomes, sample spaces, events, mutually exclusive events, Multiplication theorem on probability, Conditional probability, Independent events, Total probability, Baye's theorem and examples, Random variables, Independent random variables, Discrete and continuous probability distributions, Distribution functions, Mathematical expectation, Variance, Standard deviation, Special probability distributions, binomial distribution, poisson distribution, normal distribution, Relation between the binomial, poisson, and normal distributions, Central limit theorem.

Text Book:

1. *Stephen H. Friedberg Lawrence E Spence and Arnold J Insel, Elementary Linear Algebra: A Matrix Approach (2nd ed.), Pearson India, 2019. ISBN 978-0128119051.*
2. *Sheldon M. Ross, Introduction to probability and statistics for engineers and scientists (6th ed.), Elsevier, 2021. ISBN 978-9351073987.*
3. Michael Baron, Probability and Statistics for Computer Scientists (3rd ed.), Chapman and Hall and CRC, 2019. ISBN 978-1138044487.

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 Computer Applications				
BCA1006	Environment and Sustainability	L	T	P	C
Owning School/Department	Computer Science and Engineering	2	0	0	2
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: The students will 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: **6 lecture hours**
Environmental sustainability, ecosystems and climate change Introduction to environmental sustainability – Sustainability and population growth – 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: **5 lecture hours**
Biodiversity and its conservation: Biodiversity-Value of biodiversity-Threats to biodiversity-Conservation of biodiversity-Case studies.

UNIT 3: **8 lecture hours**
Natural resources: Natural resources - Associated problems with natural resources – renewable and non-renewable energy – Water and Agriculture - Agriculture and Food – Problems and Solutions.

UNIT 4: **9 lecture 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.

Text Book:

1. *Erach Bharucha, Textbook of Environmental Studies for Undergraduate Courses (3rd ed.), Orient Blackswan Pvt. Ltd., 2021. ISBN 978-9389211788.*
2. Mahua Basu and S. Xavier, Fundamentals of environmental studies (1st ed.), Cambridge press, 2017. ISBN 978-1107536173.

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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 Computer Applications				
BCA2001/ BCA2051	Fundamentals of Microprocessors and Computer Architecture	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: Understand about modern architecture and microprocessors and the design techniques.
CO2: Evaluate various design alternative of computer architecture based on CPU performance, memory, I/O.
CO3: Understand instruction sets and implement with assembly programme and design application specific processor using HDL.

Course Contents:

UNIT 1: **14 lecture hours**

Why Microprocessor and Computer Architecture, Microprocessor Architecture, CPU Registers, Segment Registers, General Purpose Registers, Bus Interface Unit, Address bus, data bus and control bus, Control Unit, ALU, Memory unit, Architectural overview and comparison between 32-bit and 64-bit processor, Microprocessor Pin Configuration, AI Processor, Comparison of AI Processor with regular Microprocessor, ARM processor Architecture, Instruction Set Architecture, Instruction interpretation and execution, Addressing Modes, Immediate, Direct, Indirect, PC-relative, Indexed, Arithmetic and logic unit, Register configuration of Signed Magnitude Addition-Subtraction Algorithm,
Register configuration of 2's complement Addition Subtraction Algorithm, Signed Magnitude Multiplication Algorithm, Booth's multiplication algorithm.

UNIT 2: **14 lecture hours**

CPU – Memory interconnections, Organization of memory modules, Principle of locality, Cache Memory, Cache Memory Mapping Techniques, Associative, Direct, Set Associative, Case Studies, Input/Output techniques, Programmed controlled I/O transfer, Interrupt controlled I/O transfer, Different types of Interrupts, DMA controller, Secondary Storage – solid-state drive (SSD), Comparison of SSD with HDD, Pipelining, pipeline hazards, Instruction level parallelism and advanced issues, RISC and CISC paradigm, Design-issues of a RISC processor, Multiprocessor system and its characteristics.

Laboratory:

Designing of various components (Adder, Subtractor, Comparator, Logical Operation, MUX, DEMUX, Register) of 16-bit ALU, Integrate all the components designed in Lab1 and prepare a functional ALU using FPGA, Introduction to Assembly Language programming with MARS Simulator, Implementation of different Arithmetic operations in MARS Simulator, Taking user input in Assembly code, MIPS Logical, Conditional and Unconditional branch Instructions, String Handling in MIPS, taking user string input from user at runtime, Subroutine handling, Assembly loop control structure, Array Declaration in MIPS Simulator, Floating point number representations in MIPS, Application of Cache Simulator in MIPS.

Text Book:

1. *William Stallings, Computer Organization and Architecture (11th ed.), Pearson, 2018. ISBN 978-0134997193.*

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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 Computer Applications				
BCA2002/ BCA2052	C Programming	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 explain various concepts in C programming language and understand the problem-solving aspect.
CO2: To utilize the basics of C programming in problem solving.
CO3: To implement concept of pointer and perform I/O operations in files and make use of concepts in finding solutions to real-life problems.

Course Contents:

UNIT 1: **8 lecture hours**

Program structure, Communications with the Operating System, Library Functions, Pre-processor Directives, Debugging and Efficiency, Memory Models, Data Types-Simple C data types, Integer Data types, Floating Point types, Derived Data types, The ASCII Character Set, Compilation and Linking, Types of compilers, Decision making, Loops, Switch statement, Goto statement, Null statement, Comma operator, setjmp functions, longjmp functions, Storage classes: automatic variable, external, static, register, Arrays, Array Indexing, Using Array Names as Pointers, Character Arrays.

UNIT 2: **10 lecture hours**

Advanced data types: #define statement, Variable length array, Flexible array members, Complex number type, Type Qualifiers: Const, Volatile, Restrict, Functions, Pass by value, Pass by reference, Command Line Arguments, Structures, Arrays of Structures, Structures of Arrays, Structures of Structures, Bit Fields in Structures, offsetof(), Macro, unions, Typedef, Typecasting, Implicit type casting, Explicit typecasting, Pointers- Declaration, NULL pointers, Indirection, Pointer to array, Pointer to function, Pointer to structure, Arrays of Pointers, Passing pointers to functions.

UNIT 3: **10 lecture hours**

File handling, Recursive functions, Memory allocation in a recursive method, Dynamic memory allocation, Global Memory versus Local Memory, Error handling in C, Global Variable Errno, perror() and strerror(), Exit status, Divide by zero errors, Interfacing C with Python code: Calling C functions from Python, Calling python functions from C, Threads: Creating a thread, Passing arguments and returning values, Common thread functions, Thread synchronization concepts, Mutexes, condition variables.

Laboratory:

Students will implement the following programs in C language on a Linux based platform using GCC compiler.

Text Book:

1. *Byron Gottfried, Outline of Programming with C (4th ed.), McGraw Hill Education, 2018. ISBN 978-0070145900.*
2. E. Balaguruswamy, Programming in ANSI (8th ed.), McGraw Hill Education, 2018. ISBN 978-9351343202.

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Name of Program	Bachelor of Computer Applications				
BCA2003/ BCA2053	Data Structures: Concepts and Practice	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	1	2	5
Pre-requisites/Exposure	-				

Course Outcomes (COs)

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

CO1: Articulate the design, use and associated algorithms of fundamental and abstract data structures.
CO2: Examine various searching and sorting techniques based on complexity analysis for applicative solutions.
CO3: Demonstrate hands-on experience on implementing different data structures.
CO4: Build optimized solutions for real-word programming problems using efficient data structures.

Course Contents:

UNIT 1: **10 lecture hours**

Why Data Structures, First C++ Program, Execution Cycle of C++ Program, OOPs Concepts, C++ Inheritance, Multiple inheritance, Friend Function, Runtime Polymorphism, Time Complexity: Asymptotic Analysis, Big-Omega, Big-Theta, Big-Oh Notation, Handling Arrays, Insertion, Deletion, Traversal, Linear Search, Recursion, Binary Search, Tower of Hanoi, Sorting, Bubble Sort, Selection Sort, Insertion Sort, Merge Sort, Shell Sort, Counting Sort.

UNIT 2: **10 lecture hours**

C++ Pointers, Structures and Unions, Linked List, Singly Linked List Implementation, Singly Linked List Traversal, Searching, Insertion, Deletion, Polynomial Handling, Circular Linked List, Traversal, Insertion, Deletion, Stacks, Traversal, Insertion, Deletion, Infix to Postfix Conversion, Post-fix Expression Evaluation, Queues, Simple Queue Insertion, Deletion, Traversal, Circular Queue Insertion, Deletion, Traversal.

UNIT 3: **11 lecture hours**

Tree Data Structures, Height, Complete, Full, Perfect Trees, Binary Search Trees, Pre-Order, In-Order, Post-Order, BST Searching, BST Insertion, BST Deletion, Heaps, Min-Max Heaps, HeapSort, Hashing, Hash Functions, Hash Tables, Hashing Collision Resolution Strategies: Separate Chaining, Open Addressing, Double Hashing, Graphs, Different Types of Graphs, Graphs Representations, Incidence Matrix, Adjacency Matrix, Graphs Traversals: BFS, DFS, Topological Sort.

UNIT 4: **11 lecture hours**

Height Balanced Trees: AVL Trees, Balanced Factor, Rotations, Insertion, Deletion, Red Black Trees, Insertion, Deletion, B Trees, Insertion, Deletion, B+ Trees, Insertion, Deletion, Disjoint Sets, Path Compression, Union Finding Algorithm, van Emde Boas Tree.

Laboratory:

The laboratory of Data structures is designed to provide a practical exposure to the students about the concepts and topics taught in the classroom sessions. Implementing the learnt concepts using C++ will help the students to have a better understanding of the subject.

Text Book:

1. *Yedidyah Langsam, Moshe J Augenstein and Aaron M Tenenbaum, Data Structures using C and C++ (2nd ed.), Pearson Education, 2015. ISBN 978-9332549319.*
2. Ellis Horowitz, Sartaj Sahni and Dinesh Mehta, Fundamentals of Data Structures in C++ (2nd ed.), Universities Press, 2008. ISBN 978-8173716065.

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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 Computer Applications				
BCA2004/ BCA2054	Information Management System 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: 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: **10 lecture hours**

Purpose of IMS, Real-life applications of Data-Intensive systems, Typical system challenges, Data independence, Database system architecture levels, Role of several databases, ER diagram: Entity-set, Attributes, Relationships, Cardinality ratio, EER diagram: Specialization, Generalization, Constraints of EER, Aggregation, ER to Relational model, Relational model, Structure of relational databases, Constraints of relational model, Relational algebra: Basic and derived operator, Tuple relational calculus.

UNIT 2: **10 lecture hours**

Functional dependency – definition, trivial and non-trivial FD, Armstrong's axioms, closure of FD set, Closure of attributes, Irreducible set of FDS, Normalization, 1NF, 2NF, 3NF, BCNF, Decomposition using FD, Dependency preservation, Multivalued dependency, 4NF, join dependency, 5NF, Query optimization, Measures of query cost: selection operation, sorting, join, Evaluation of expressions, Transformation of relational expressions, Estimating statistics of expression results.

UNIT 3: **10 lecture hours**

Properties of transactions, Serializability of transactions, testing for serializability, System recovery, Two-Phase Commit protocol, Recovery and Atomicity, Log- based recovery, concurrent executions of transactions, Locking mechanism, Solution to concurrency related problems, Deadlocks, Two-phase locking protocol, Isolation, Intent locking, Discretionary Access Control, Mandatory Access Control, Authentication, Authorization and access control, DAC, MAC and RBAC models.

UNIT 4: **12 lecture hours**

Pipelining, Streaming algorithms framework, Turnstile model, Cash register models, Sliding window model, Data warehouse, Operational data store, Star schema, Snowflake schema, Data cube concept, OLAP, Cube and Roll-up, NoSQL database systems framework, Column stores, RDF stores, HBase, Big Data, Hadoop MapReduce architecture, Distributed Database Systems framework (DDS), Need for Data Privacy, Privacy law, Anonymity models, Privacy in Cloud and Big Data.

Laboratory:

The laboratory of Data structures is designed to provide a practical exposure to the students about the concepts and topics taught in the classroom sessions. Implementing the learnt concepts using C++ will help the students to have a better understanding of the subject.

Text Book:

1. *Elmasri, Ramez and Shamkant B. Navathe, Fundamentals of database systems (7th ed.), Pearson, 2015. ISBN 978-0133970777.*
2. Date C.J, An Introduction to Database (8th ed.), Addison-Wesley Pub Co, 2003. ISBN 9780321197849.

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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 Computer Applications				
BCA2005/ BCA2055	System and Software Development Life Cycle	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 of software products.
CO3: To implement development life cycle through the IDE, UML, and Git.

Course Contents:

UNIT 1: **7 lecture hours**

Importance of Software Engineering, Phases of software development lifecycle, SDLC case study, Software process model, Waterfall model, V Model, Prototyping model, Incremental model, RAD Model, Spiral model, Choosing a model, Lifecycle documents, Agile model, Need of agile, Version ControlSystem, Distributed VC, Git repository, Git online and Desktop, Check-in, and check-out code in repository, Create branch and merging branch, Git + Eclipse/IDE.

UNIT 2: **9 lecture hours**

Agile manifesto, Agile principles, Agile development methods, Extreme programming (XP), XP principles, Test first development, Refactoring, Pair programming, Scrum, Product backlog, Sprint cycle, Continuous integration, Requirements engineering, Issues in capturing requirements, Requirement elicitation, Requirement analysis, Functional and Non-functional requirements, Requirement specification, Requirement prioritization, User stories, Acceptance criteria, Requirement validation and verification, UML, Use case, Use case Diagram, Include and extend relationship, Generalization in use Case, Top down and bottom-up approach in use case diagram, Guidelines for creating use case diagrams.

UNIT 3: **6 lecture hours**

UML behavioural diagrams, Activity diagram, Activity diagram with swimlane, UML structural diagrams, Class diagram, Relationships in class diagram, Sequence diagram, Rules of creating sequence diagram, Description of relationship between use-case, activity, and sequence diagram, Architectural design, Cohesion, Coupling, Early locking of architecture, Architectural pattern, MVC pattern.

UNIT 4: **6 lecture hours**

Layered architecture, Repository architecture, Client server architecture, Software architect, roles, and responsibilities, Pipe and filter architecture. Reverse engineering, Horseshoe model, Software cost estimation, Cost estimation factors, COCOMO model, Software quality assurance and testing Designing test cases, Black box testing

Laboratory:

The course will cover labs in the following areas: Getting used to eclipse and GitHub, hands-on session on software design via Visual Paradigm, Designing and inspecting SRS, software testing using Junit approach.

Text Book:

1. *Pressman R. and Maxim, Bruce R., Software Engineering (9th ed.), McGraw Hill International, 2019. ISBN 978-1260423310.*
2. Steve, Code Complete 2e (Developer Best Practices) (2nd ed.), Pearson Education, 2004. ISBN 978-0735619678.

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Name of Program	Bachelor of Computer Applications				
BCA2006	Mathematics for Computer Applications	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: Solve real-world problems using mathematical model.
CO2: Utilize abstract language to analyze computational thinking.
CO3: Correlate mathematical models and ideas to well-known problems of computer science.

Course Contents:

UNIT 1: **14 lecture hours**

Limit at a Point, Properties of Limit, Computation of Limits of Various Types of Functions, Continuity at a Point, Derivative, Partial Derivatives, Derivatives of Sum, Differences, Product & Quotients, Chain Rule, Derivatives of Composite Functions, Logarithmic Differentiation, Rolle's Theorem, Mean Value Theorem, Gradient, Directional Derivatives, Taylor's Theorem, Taylor Series, Taylor's Theorem in Multiple Variables, Hessian, Maxima, Minima, Second Derivative Test,Lagrange Multiplier Method, Convexity, Concavity, L'Hospital Rule, Fixed Point Iteration Method, Power Series, Riemann Integration.

UNIT 2: **20 lecture hours**

Fundamental Theorems of Calculus, Riemann Sum, Improper Integrals, Beta-Gamma Functions, Differentiation under integration, Integral as Limit of Sum, Fundamental Theorem of Calculus, Indefinite Integrals, Methods of Integration Substitution, Integration by parts, Partial Fractions, Double Integrals, Change of Variable in a Double and Triple Integrals, Area of a Parametric Surface and surface integral, Surface Area, Surface Integrals, Line Integrals Green's Theorem and Applications, Area between two curves, Polar Coordinates, Volumes by slicing, Washer and Shell Methods, Length of a plane curve, Areas of Surfaces of Revolution, Review of vectors, Calculus of Vector Valued Functions, Functions of Several Variables, Limit, Continuity and Differentiability.

UNIT 3: **08 lecture hours**

The Real Number System, Archimedean Property, Convergence of a Sequence, Monotone Sequences, Cauchy Criterion, Bolzano-Weierstrass Theorem, Limit inferior and Limit Superior, Infinite Series, Convergence Tests and Alternating series

Laboratory:

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

Text Book:

1. *George B. Thomas, Joel Hass, Christopher Heil and Maurice D., Calculus (14th ed.), Pearson Education, 2018. ISBN 978-9353060411.*
2. Robert G. Bartle, Donald R. and Sherbert, Introduction to Real Analysis (1st ed.), Wiley, 2021. ISBN 978-9354244612.

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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 Computer Applications				
BCA3001/ BCA3051	Principles of Object Oriented Programming using Java	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 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: 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**

Input output program using command line, Platform independence of Java (JVM), Operators (unary, arithmetic, logical, shift left, shift right, ternary, assignment), if/else, Switch, while, For, do-while, Object Oriented concepts, Objects Lifecyle: creation, dereference, garbage collection, Wrapper classes (Boolean, Integer, Double, Character), Autoboxing, unboxing, String (concat, indexOf, split, length,toLowerCase, toUpperCase, replace, trim), Array declaration,instantiation, multidimensional arrays, Create methods with arguments and return values, Static variables, Static methods, Static blocks, Constructors and destructors, Instance Initialization Blocks, Access modifiers (public, protected, private, default), Encapsulation, Inheritance, single, multilevel, Hierarchical.

UNIT 2: **11 lecture hours**

Polymorphism, method overloading, method overriding, Abstract class, abstract methods, non availability of multiple inheritance, interfaces, Interfaces vs abstract class, Nested interface, Anonymous class, Inbuilt Packages, User defined packages, Array List collection, Vector collection, Exception handling, Checked and unchecked exception, try, catch, finally, Throw, Throws, File handling.

UNIT 3: **11 lecture hours**

Thread and process, Multithreading, Thread Lifecycle, synchronization, Swing features, Hierarchy of Swing classes, MySQL database, JDBC Connection, getConnection, createStatement, executeQuery, JEE (client-server architecture for web based applications), Servlet Life cycle, Running Servlet, Generic Servlet, HTTP Servlet, Servlet Config, Servlet Contest, Servlet to handle Get and Post Methods, Startups on programming, Session Management.

UNIT 2: **10 lecture hours**

JSPs, Struts framework, Struts architecture, Regular expressions (Lambda expressions), Collection framework, HashMap, LinkedHashMap, TreeMap, Java for android, RMI, CORBA, Hibernate framework, Spring framework.

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 Book:

1. *Herbert Schildt, Java: The Complete Reference (10th ed.), McGraw Hill Education, 2017. ISBN 978-9339212094.*
2. Dave Wolf and A.J. Henley, Java EE Web Application Primer: Building Bullhorn: A Messaging App with JSP, Servlets, JavaScript, Bootstrap and Oracle (1st ed.), O'Reilly Media, 2017. ISBN 978-1484231951

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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 Computer Applications				
BCA3002/ BCA3052	Operating System Concepts	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 the structure and the services provided by the Operating System.
CO2: Define, restate, discuss and explain the policies for scheduling, deadlocks, memory management, synchronization, system calls, and file systems.
CO3: Awareness of distributed Operating System, cloud computing, and Virtualization.

Course Contents:

UNIT 1: **10 lecture hours**

Operating system, Organization of OS, Abstractions by OS, Features and roles of OS, Evolution of OS, Operating system architecture: Monolithic, Layered, Microkernel, Virtual machines, Client-Server, Exokernel, 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 Threads, CPU scheduling concepts, metrics, methods, CPU Scheduling Algorithms, First Come First Served (FCFS), Shortest-Job-First (SJF), Shortest Remaining Time First (SRTF), Priority Scheduling, Round Robin Scheduling, Multilevel Queue Scheduling and Multilevel Feedback Queue, Advanced Scheduling Algorithm: Highest response ration next, Lottery scheduling, Inter process communication, Shared Memory Method, Message passing method and its types.

UNIT 2: **8 lecture hours**

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 prevention, Deadlock avoidance (Banker's algorithm), Deadlock detection, Resource allocation graph, Deadlock recovery.

UNIT 3: **10 lecture hours**

Memory management, Memory management techniques – contiguous and non-contiguous, Contiguous: Fixed and variable length partitioning, Allocation policies, Android OS, 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, OS design: MAC, and iOS.

Laboratory:

Basic Shell Programming Commands such as PATH, man, echo, printf, script, passwd, uname, who, date, stty, pwd, cd, mkdir, rmdir, ls, cp, mv, rm, cat, more, wc, lp, od, tar, gzip, file handling utilities, security by file permissions. Control Statement and Expressions, Looping, Arrays and String, Functions in C. File Handling and pointers in C. System calls: write, read, open, lseek, and dup system call. Process Duplication System call, wait system call, Orphan Process. Zombie Process, excel system call. system vs excel calls, sleep system calls. Threads creation using different functions such as pthread, pthread_create, pthread_join. Implement different process scheduling algorithms. Simulate Deadlock using threads. Pipelining-popen/pclose functions, pipe function, named pipes (mkfifo) function, message queues. Process synchronization using mutex locks, Process synchronization using semaphores, Dining Philosopher Problem. Develop, test, and run demo code on

Text Books:

1. *Silberschatz, A., Galvin, P.B. and Gagne, G, Operating System Concepts(10th ed.), John Wiley, 2018. ISBN 978-1-119-32091-3.*
2. *Stallings and Willam, Operating Systems Internals and Design Principles (9th ed.), Prentice Hall, 2021. ISBN 978-0134670959.*
3. Andrew S Tanenbaum and Herbert Bos, Modern Operating Systems(1st ed.), Pearson, 2021. ISBN 9789332575776

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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 Computer Applications				
BCA3003/ BCA3053	Algorithm Design Strategies	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	1	6	7
Pre-requisites/Exposure	-				

Course Outcomes (COs)

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

CO1: Examine and Analyse 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, Analysing 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-fuelkerson, Dynamic Programming:- Introduction, Principle of Optimality, Calculating Binomial Coefficient, 0-1 Knapsack, Matrix chain multiplication, Longest Common Subsequence, All Points Shortest path Floyd Warshall, Largest Divisible Subset.

UNIT 3: **8 lecture hours**

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

UNIT 4: **8 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. The preferred language of the course will be JAVA. Furthermore, the students will be actively participating in open-source projects available at GitHub.

Text Book:

1. *Cormen, Leiserson, Rivest and Stein, Introduction to Algorithms (3rd ed.), The MIT Press, 2010. ISBN 978-0262033848.*
2. *Ellis Horowitz, Sartaj Sahni, Sanguthevar and Rajasekaran, Computer Algorithms/C++ (2nd ed.), The Orient Blackswan, 2019. ISBN 9386235145.*
3. Narsimha Karumanchi, *Algorithm Design Techniques: Recursion, Backtracking,Greedy, Divide and Conquer and Dynamic Program* (1st ed.), Career Monk Publications, 2018. ISBN 978-8193245255.

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 Computer Applications				
BCA3004	Economics and Business Perspective of IT Projects	L	T	P	C
Owning School/Department	Computer Science and Engineering	2	0	0	2
Pre-requisites/Exposure	-				

Course Outcomes (COs)

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

CO1: Basic understanding of various concepts in Economics.
CO2: Apply the concepts of scarcity, choice and opportunity costs for making smart choices.
CO3: Explain the relationship between supply, demand, and prices in an economy.

Course Contents:

UNIT 1: **6 lecture hours**

Meaning and nature of Economics, Relation between science, engineering, technology and economics; Meaning of Demand, Determinants of Demand, Shifts in demand, Law of Demand, Price Elasticity of Demand &Types, Income Elasticity, Cross price Elasticity, Determinants of Elasticity, uses and importance of elasticity.

UNIT 2: **6 lecture hours**

Concept of Supply: Law of Supply, Factors affecting Supply, Elasticity of supply. Demand Forecasting: Introduction, Meaning and Forecasting, Methods or Techniques of Demand Forecasting, Criteria for Good Demand Forecasting, Demand Forecasting for a New Product.

UNIT 3: **10 lecture hours**

Cost Analysis- Introduction, Types of Costs, Cost-Output Relationship: Cost Function, Cost-Output Relationships in the Short Run, and Cost-Output Relationships in the Long Run; Short run and long run, Break- Even Analysis; Production functions: laws of variable proportions, law of returns; Economies of scale: Internal and external. Market Structure: Market Structure Perfect Competition, Imperfect competition – Monopolistic, Oligopoly, duopoly sorbent features of price determination and various market conditions.

UNIT 4: **12 lecture hours**

Nature and characteristics of Indian economy, concepts of LPG, elementary concepts of National Income, Inflation and Business Cycles, Concept of N.I. and Measurement., Meaning of Inflation, Types and causes, Phases of business cycle. Investment decisions for boosting economy(National income and per capital income). Introduction to Economic Growth, Externalities, technical progress and growth, Total factor productivity, Capital and Labor saving technical progress, financing development from domestic resources, International trade and International Inequality.

UNIT 5: **8 lecture hours**

Role of Government, Infant industry argument, Market failure, Government Failure, Structural adjustment facility of International Monetary Fund, World Bank, Experience of South East Asia and Latin America Countries MARKET FOR LAND AND CREDIT.

Text Book:

1. *Salvatore D, Principles of Microeconomics (3rd ed.), Oxford University Press, 2015. ISBN 978-8120350786.*
2. Robert Pindyck and Daniel Rubinfeld, Microeconomics (8th ed.), Pearson Education, 2017. ISBN 978-9332585096.

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 Computer Applications				
BCA3005	Ethics for Professionals, Patents, Copyrights and IPR	L	T	P	C
Owning School/Department	Computer Science and Engineering	1	0	0	1
Pre-requisites/Exposure	-				

Course Outcomes (COs)

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

CO1: Explain and Practice the professional ethics for engineers.
CO2: Examine and understand the patent law, and how patents are prosecuted and enforced.
CO3: Articulate the importance of intellectual property laws in modern engineering.

Course Contents:

UNIT 1: **8 lecture hours**

The rationale behind studying ethics, patents, copyrights, and intellectual property rights, ethical considerations, different investigative approaches, ethical dilemmas, individual moral autonomy, theories addressing morally correct actions such as Kohlberg's and Gilligan's, Models of Professional Roles, Self-interest, customs, and religion, uses of ethical theories, Patents, Patentable Subject Matter, Novelty, Non-Obviousness, Patenting Process, Infringement and Searching, Patent Applications, Claim Drafting, Patent Prosecution, Design Patents, Business Method Patents, Foreign Patent Protection, Computer-Related Inventions, Patent Enforcement, Technical Design-Around.

UNIT 2: **6 lecture hours**

Copyrights Subject matter of Copyright entitlements of copyright owners, aspects of authorship, ownership considerations, licensing and assignment of copyright, the registration process for copyright and the relevant authorities, Copyrights for Technology Protection, Intellectual Property Rights, IP Law Overview, Mask Works, Trade Secrets, Trademarks, Engineers as Expert Witnesses.

Text Book:

1. *H B Rockman, Intellectual Property Law for Engineers, Scientists, and Entrepreneurs (2nd ed.), preneurs (2nd ed.), Wiley-IEEE Press, 2020. ISBN 978-1119381976.*
2. Yang hu, Algorithms C++ (1st ed.), Cengage Learning, 2020. ISBN 9798676695750. William Stallings, Intellectual Assets for Engineers and Scientists (1st ed.), Creation and Management, CRC Press, 2018. ISBN 978-1498788472.

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 Computer Applications				
BCA3006/ BCA3056	UI / UX Design	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills and values:

CO1: To explain UI design with components and user experience designing.
CO2: To implement UI/UX components and libraries.

Course Contents:

Unit I **16 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, SocioOrganizational and stakeholder requirements, Social Computing, Experiments designing concepts and methods, Communication and collaboration models, Mobile Ecosystem: Platforms.

Unit 2 **14 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 **12 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. Samit Bhattacharya, Human-Computer Interaction User-Centric Computing for Design (1st ed.), McGraw Hill, 2019. ISBN 9789353168056.
2. Nirmalya Thakur; Parameshachari B.D, Human-Computer Interaction and Beyond: Advances Towards Smart and Interconnected Environments (Part I), (1st ed.), Bantham Books, 2021. ISBN 9789814998826.

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-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 Computer Applications				
BCA4001/ BCA4051	Network Essentials	L	T	P	C
Owning School/Department	Computer Science and Engineering	2	0	2	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: Examine the functionality of the different layers within network architecture. Introduction to computer networks concepts, OSI and TCP/IP, Local area networks, Reliable data delivery, Routing and forwarding, Network applications and security in computer networks.

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: **11 lecture hours**

Transmission Media, Ethernet, Bluetooth, Data Link layer, CSMA, CSMA/CD. Motives Behind Computer Networks, Network Applications in Various Fields, Transmission Medium Types, Devices Interconnections, Local Area Networks (LANs), Varieties of LAN Topologies: Bus, Ring, Star, Mesh, Hybrid Configurations, Overview of the OSI Reference Model, TCP/IP Protocol Suite Insights. Delving into the Physical Layer: Its Services, Switching Techniques, Ethernet, Bluetooth, and Understanding the Data Link Layer: Services Offered, Framing, Switching Operations. Ensuring Reliable Data Delivery: Error Detection, Correction, Flow Control Mechanisms like Stop-and-Wait, Go Back-N, S-R Protocol, Error Control, Retransmission Methods, Timers Usage. Medium Access Sublayer Fundamentals: Channel Allocations, LAN Protocols, ALOHA Protocols, CSMA, and CSMA/CD.

UNIT 2: **8 lecture hours**

Network Layer Protocols: Services (IP, ICMP), IP addressing, sub netting, Super netting (CIDR), IPV4, IPV6, 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.

UNIT 3: **9 lecture hours**

Session Layer Functions and Protocols, Presentation Layer Services and Protocols, Overview of Application Layer Services and Protocols, Application Layer Protocol Examples, Remote Login Principles, Basics of Cryptography, Symmetric and Public Key Encryption, Digital Signatures, Introduction to Firewalls, CASS Implementation, Content-Aware Search System, Service-centric networking, Software-defined networking, 4G and 5G Networks, Body area sensor Networks, Satellite networks.

Laboratory:

Installation of Packet tracer. Practice of basic commands in network communication Practice of various devices in Packet Tracer. Implementation of different Network Topologies using Packet Tracer (e.g., Bus, Ring, Mesh, Star and Hybrid topology). Network Physical Components Hands-on Building Straight

Through and Crossover Unshielded Twisted Pair (UTP) Network Cables and test the cable using the LAN tester. Bit stuffing and Bit unstuffing using Programming. Design of Virtual LANs in Packet Tracer. Implementation of Flow Control using Programming. Designing two separate network (using switch) and connect them using wireless/wired router in Packet Tracer. Designing a network using Fixed Length Subnet Masking and Variable Length Subnet Masking. Configuration of RIP and OSPF routing Protocols. Installation of Wireshark, Packet Capturing and Monitoring using Wireshark, Filtering on network packets using Wireshark. Implementation of Data Encryption/ Decryption.

Text Book:

1. *B. A Forouzan., Data communication and Networking (5th ed.), McGraw Hill, 2021. ISBN 10: 1260597822.*
2. *Andrew S. Tanenbaum and David J. Wetherall, Computer Networks (6th ed.), Pearson, 2021. ISBN 9780137523214.*
3. W. Stallings, Data and Computer Communication (9th ed.), -, 2013. ISBN ISBN 978-9332586932

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 Computer Applications				
BCA4002	Seminar on Special topics in Computer Applications	L	T	P	C
Owning School/Department	Computer Science and Engineering	0	1	0	1
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: To articulate speech preparation and presentation techniques, audience awareness and self-awareness along with the cultivation of self-confidence.
CO2: To examine the ability to present scientific material in visual, written, and oral form including the formulation of an effective presentation on a topic in the Computer Science domain.
CO3: To explain an ability to listen to a scientific presentation with the discussion of the strengths and weaknesses of a speaker's presentation.

Course Contents:

UNIT 1: **14 lecture hours**

Introduction to Seminar Presentation: Importance and relevance of seminar presentations in academic and professional settings. Overview of the course objectives and expectations. Topic Selection and Research: Techniques for identifying and selecting relevant topics in computer science.
Research methodologies to gather information on emerging engineering research areas and industry requirements. Presentation Skills Development: Techniques for effective verbal communication. Design principles for visual aids and slides.
Structuring and organizing written content for seminars. Practical Application: Individual and group exercises to practice presentation skills. Peer reviews and constructive feedback sessions. Emerging Trends and Industry Insights: Guest lectures from industry professionals. Exploration of current and future trends in computer science. Seminar Preparation: Crafting and refining seminar content. Guidance on preparing effective visual aids and written materials. Presentation Delivery: Opportunities for students to deliver seminars to the class. Feedback sessions and self-reflection. Final Assessment: Final seminar presentations incorporating all learned skills. Evaluation based on content, delivery, and overall effectiveness.

Text Book:

1. *Ford, Neal, Matthew McCullough and Nathaniel Schutta, Presentation patterns:Techniques for crafting better presentations (1st ed.), Addison- Wesley, 2012. ISBN 978-0321820808.*

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 Computer Applications				
BCA4003/ BCA4053	Mobile Programming	L	T	P	C
Owning School/Department	Computer Science and Engineering	2	0	2	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: Develop simple mobile applications using Android environments.
CO2: Discover the features of android application development.
CO3: Apply Java programming concepts to Android application development.

Course Contents:

UNIT 1: **8 lecture hours**

Why Mobile Programming, What is Android, Android Environment Setup, Android JDK and SDK tool setup, Android development tools, Android virtual device, Android application development, Creating and managing activities, Declaration of activities in Android Manifest, Activity stack, Activity lifecycle, Action, Category, Implicit intent, Explicit intent, Resources, Security and permissions, Debugging of Android application, User Interface and controls, Android input controls, Methods in Activity class, Spinner, Elements, Spinner List items, List controls, String array, Spinner list with string array values, Creation of custom header, list view, Array Adapter, Custom Adapter..

UNIT 2: **11 lecture hours**

Time Picker, Date Picker, Image View component, Layout managers, Absolute layout, Frame layout, Linear layout, Relative layout, Table layout, Asynchronous media preparation, Managing media player state, Setting up audio playback, Hardware setup for volume and playback control, Transient audio focus, Establishing video playback, Video encoding formats, Video encoding profiles and parameters, Design considerations of Camera, Declaration in Android manifest file, Camera roll notification, normal view, big view, Simple notification app, Update notification, Notification activities, Inbox big view style, Compatibility issue, Remove notification, Toast app, LayoutInflater, Custom Toast layout app, Creation and use of styles, Inheritance, Android themes, Customizing themes, Launcher icon, Draw Nine patch, Setting up frame by frame animation, Apply and start the animation, Assigning an Interpolator, Elements, Working in 2D, Drawing with canvas.

UNIT 3: **9 lecture hours**

Menus, Creating option menu, Click event handling for menu items, Creation of floating context menu, Building of Alert dialog, Code for action buttons, Action button for alert dialog, Progress dialogs, Close button to close dialog, Android support for multiple screen, Screen support, Configuration qualifier, Size, Density, Orientation and aspect ratio, Alternate layout and relative sizes for different bitmap density, Locations and maps, Incorporation of location and maps API, Using GPS to find current location, Create GPS manager class, Retrieve user's current location, Preferences and data storage, Creation of preferences activity, PreferenceActivity, MainActivity, Database creation using SQL helper, Store information in the database, Android widgets, Information and Collection Widgets, Control and Hybrid Widgets.

Laboratory:

Android Environment Setup, Android Studio Installation, JDK Installation, Initiating JDK to android SDK, Anatomy of Android Application, Manifest file, main activity file, strings file, layout file, Creation of first Android project, Creation of app and launch, Setup real device, Testing the app in the emulator and real device, Building of a simple user interface in Android Layout Editor, text box, Textbox of flexible size, Button, UI strings, Run the user interface in android phone, Building of an intent, Responding to send button, Creation of second activity, Using of one activity to other activity, Addition of text view, Display of message, Addition of navigation, Use of Fragments, Fragments as a part of one activity, Fragment class in Android studio, Combine multiple fragments in one activity, Implementation of Fragment in Android, Start Services, Bound Services, Creation of basic building block of a service, Creation of Broadcast Receiver, Registering Broadcast Receiver, Creation of system events like 'battery low', 'USB connected' etc, Supply the data from one app to other, Stores the data for some extent, Creation of notification builder, Getting notification from different apps, Setting notification properties, Attach actions, Issue the notification, Location based services, Getting the latitude and longitude of the current location, Fetching the current location, Store data in Android, Local storage, Data store to a text file on a device, Stores all relational database features such as .text, .jpeg, .png, etc.

Text Books:

1. *Silberschatz, A., Galvin, P.B. and Gagne, G, Operating System Concepts (10th ed.), John Wiley, 2010. ISBN 978-1-119-32091-3.*
2. *Stallings and Willam, Operating Systems Internals and Design Principles (9th ed.), Prentice Hall, 2011. 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 Computer Applications				
BCA4004/ BCA4054	Introduction to Cloud Computing	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills and values:

CO1: To articulate cloud computing principle and its 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 I **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 II **12 lecture hours**

Microservices, Service-Oriented Architecture, REST API, IP Addressing, Subnetting, Supernetting, 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, TaskVM Mapping, Auto Scaling, Load Balancing.

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

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-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))

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))

Specialization Core I and 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 Computer Applications				
BCA3101/ BCA3151	Full Stack Development	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

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.

Course Contents:

UNIT 1: **8 lecture hours**

The Importance of Full Stack Development, Contrasting Web Development with Full Stack Development, Understanding Client-Server Architecture, Principles of Three-Tier Architecture, Exploration of Stacks like MEAN, MERN, Rails, Django, and LAMP, Comparative Analysis Between MEAN and MERN Stacks, 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**

The Significance of CSS, Employing W3C CSS Validator, Syntax Overview, CSS Types, Selectors, Cascading, Inheritance, Specificity, Measurement Units, Managing Element Width and Height, Box Model Layout, Comparison between Border Box and Content Box, Bootstrap Grid System for Responsive Web Design, CSS Pre-processors like Less and Sass with their Characteristics.

UNIT 3: **8 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.), Shroff and O'Reilly Media, 2020. ISBN 978-935213996.*
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.*

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 Computer Applications				
BCA4101/ BCA4151	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)

By the end of this program, students should have the following knowledge, skills, and values:

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 (Hypertext Preprocessor), Java, Node.js. MERN Stack: Mongo DB, Express.js, React.js, Node.js. functional-based backend programming languages (Mongo DB), Databases, MySQL, markup language XHTML, PHP- a scripting language. PHP: server-side scripting and its syntax variable and constant manipulation, PHP code blocks: arrays, strings, function. PHP error handling, program flow control, looping, branching, file handling, directories, PHP sessions and security, processing forms on server-side, cookies, Web services, exploring Java-based web technologies: Java Database Connectivity JDBC, servlet, JavaServer Pages JSP. Web architecture model: client-server model, three-tier model, and service-oriented architecture (SOR), MVC architecture: model, view, controller, Advanced features in PHP, such as namespaces, traits, and anonymous classes, Server-Side Rendering (SSR), Exploring advanced Java technologies for web development, including JavaServer Faces (JSF) and Enterprise JavaBeans (EJB), Web Application Security, Responsive Web Design..

UNIT 2: **7 lecture hours**

Database programming: Operations and manipulating metadata, database configuration, establishing connection to MySQL server, execution of MySQL queries, Node.js: Web Applications with Node.js, Core Node.js and Packages, Events Streams, Modules: export, object, class. Loading modules from separate folders and exploring file systems, MongoDB, Features of MongoDB, MongoDB Database Tier, integration of Node.js with MongoDB, using Node.js in conjunction with MySQL, Server-side rendering, Node.js Middleware, Advanced MongoDB: MongoDB aggregation pipeline, indexing strategies, and advanced querying techniques, Data Modeling and Relationships, Node.js Event Loop and asynchronous programming, Performance Optimization: Strategies for optimizing database queries, server-side code, and overall application performance.

UNIT 3: **9 lecture hours**

REPL (read–eval–print loop) environment and commands, Backend frameworks: Django, Spring, Express. Docker Containers, GraphQL integration, API documentation, tools like Swagger API, Postman (API testing), REST (Representational State Transfer) Principles for APIs, Containerize APIs with Docker,

Serverless computing, DevOps toolkit, Advanced Django Framework, Microservices Architecture, Cloud-Native Technologies: Integration of cloud-native technologies like Kubernetes and serverless computing in web applications., Automated Testing in DevOps, Continuous Integration and Continuous Deployment (CI/CD).

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 14 using practical examples (5th ed.), Packt Publishing Limited, 2020. ISBN 978-1838987572.*
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.*

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 Computer Applications				
BCA3102/ BCA3152	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)

By the end of this program, students should have the following knowledge, skills, and values:

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: **10 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: **10 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: **8 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 startups based on data analysis, social impact of data analysis.

Laboratory:
Studio work focuses on Different Data Analysis Methods,. Techniques, Algorithms using PythonData 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 (1st ed.), Wiley, 2020. ISBN 8126502959.*
2. *Klosterman and Stephen. Data Science Projects with Python: A Case Study Approach to Successful Data Science Projects Using P (1st ed.), Packt Publishing Limited, 2019. ISBN 978-1838551025.*

Name of Program	Bachelor of Computer Applications

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))

BCA4102/ BCA4152	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)

By the end of this program, students should have the following knowledge, skills, and values:

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**

Overview of Data Mining, Principles of Data Mining, Processes Involved in Data Mining, Model for the Knowledge Data Discovery Process, Difficulties Encountered in Data Mining, Utilizations of Data Mining, and Social Consequences of Data Mining. Data and attribute type, Properties of data, Discrete and continuous attribute, Dataset types, Data quality measurement, Noise Analysis and its importance, Extracting information from different sources, Visual representation of data, Analysis of distributions and summary statistics, Exploration of connections between variables, Missing Values Segmentation, Outlier detection. Data Preprocessing, Definition, significance, and role in the data analysis pipeline, Method of Data Preprocessing, Real-world examples illustrating the importance of effective data preprocessing.

UNIT 2: **7 lecture hours**

Aggregation, Sampling, Curse of dimensionality, Dimensionality reduction, Feature selection and generation, Association rule mining, Apriori algorithm, Rule generation, Term Frequency and Inverse Document Frequency. Measuring data similarity, Similarity Metrics: Distance based measure, Information based measures, Set similarity measure, Jaccard Index, Sorenson Dice Coefficient, Model Selection Problem, Error Analysis, Data Privacy and Ethics- Importance of ensuring privacy in data analysis, Ethical considerations and responsible data handling, Outlier Detection- identifying abnormal patterns or data points, Methods for handling outliers in data analysis, Case study, Startups in Data Analysis.

UNIT 3: **10 lecture hours**

Defining and handling outliers, Techniques for defining and handling outliers in diverse datasets, Impact of outliers on model performance. Model selection, Model Development Techniques, Probabilistic models for clustering, Applications and advantages of probabilistic 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, Parametric Models, Non-Parametric Models, ANOVA, Regression Analysis, Application of ANOVA and regression analysis in prediction, Frequent Pattern Mining, Mining Closed and Max Patterns.

UNIT 3: **14 lecture hours**

Time series Model: Introduction to ARMA (AutoRegressive Moving Average) model, Understanding ARIMA (AutoRegressive Integrated Moving Average) model, Exploring ARFIMA (AutoRegressive Fractionally Integrated Moving Average) model, Factor Analysis, Model Evaluation, Techniques and metrics for evaluating model performance, Model Validation and Deployment Introduction, Comparing and Combining Models, Evaluation Charts for Model Comparison, Deploying Model, Challenges and solutions in model deployment, Assessing Model Performance, Updating a Model, Strategies for updating models based on new data, Expert Lecture from Industry, Recommendation System and Collaborative Filtering, Mining Textual Data, Temporal mining, Spatial mining, Visual and audio data mining, Ubiquitous and invisible data mining- Privacy, Security, Social Impacts of data mining, Regression analysis.

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

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 Computer Applications				
BCA3103/ BCA3153	Cloud Computing Foundation	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: To articulate cloud computing principle and its 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 and the Utilization of Cloud-Based IT Resources: An exploration of the adoption of IT resources in the cloud, Delving into Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS). Exploration of Community Cloud, Cloud Computing Characteristics, and the Challenges Inherent in Cloud Computing. Understanding the Virtualization Concept, its Types, and a Practical Demonstration of Virtualization. Evaluation of Virtualization Merits and its Role in the Cloud Computing Landscape, along with an examination of Virtualization Demerits. Practical insights into VM Placement, VM Migration, and VM Clustering, including Design Issues. Addressing the Need for Dockers and Containers, Exploring the Docker Ecosystem, and a Comparative Analysis of Hypervisor vs Docker.Top of Form.

UNIT 2: **12 lecture hours**

Need of Dockers and Containers, Docker Eco-System, Hypervisor vs Docker. Microservices, Service-Oriented Architecture, REST API, IP Addressing, Subnetting, Supernetting, 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, 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, Real-world examples of successful cloud implementations.

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

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 Computer Applications				
BCA4103/ BCA4153	Cloud Architectural Solution	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

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**

Roles in Cloud Architecture, Certifications for Solution Architects, and Competitions for Cloud Solution Architects, Cloud Computing with characteristics, Core Cloud Services, Loose Coupling, Loose Coupling Strategies, Communication in coupled components, Infrastructure Decoupling, Deployment of Scalable Web Applications, Multi-Tenancy, and 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, Principles for Delivering Cloud Services, Design Principles for Cloud Architecture, Security Principles, Reliability Pillar Principles, Performance Efficiency Pillar Principles, 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 Compliance, Implementation of Authentication Protocols, Content Delivery, Domain Name System (DNS). 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**

Federated Cloud Case Study, 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, Cloud-Native Applications, Cloud Enterprise Applications, Challenges towards Hypergrowth of cloud-native applications, Evolution of Deployment, Current Cloud Computing System Designs, Modern Cloud Architecture Integration, Structure of a Cloud-Native Application, Attributes of Cloud-Native Applications, Unifying DevOps Culture with Cloud Architectural Solutions, Software Development using Cloud PaaS. Microservices, Microservice Architecture, Microservice Architecture v/s Monolith Architecture, Developing Cloud-Native 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. Exploration of Cloud-Native Development through a Case Study, Investigating Advanced Research Topics.

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.

Text Book:

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.*

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 Computer Applications				
BCA3104/ BCA3154	Statistical Machine Learning	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	2	4
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

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 and their corresponding characteristics, Feature variable, Machine Learning, , terminology in statistics, Supervised learning, Concentration inequalities, Generalization bounds, Plugin classifiers, Least-squares methods, Bias vs Variance, Theory of generalization comprehension of underfitting and overfitting, Parametric methods, Maximum likelihood, Bayes algorithm, Minimax algorithm, Expectation-Maximization, Advantages and Disadvantages practical applications of the EM algorithm, and detailed examination specific use cases for the EM algorithm, Cross-validation Techniques, Ensemble Learning, Decision Trees and Random Forests, Neural Networks and Deep Learning.

UNIT 2: **10 lecture hours**

Bayesian versus Non-Bayesian approaches, the estimation of probability density, 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, Karush-Kuhn-Tucker (KKT) conditions, Lagrangian minimization, Primal feasibility, Dual feasibility, Complementary slackness, Bayesian Neural Networks, Kernel Methods, Sparse Coding, Bayesian Optimization.

UNIT 3: **13 lecture hours**

Basis pursuit, Polynomial Expansion, Feature maps, The "kernel trick", Vapnik-Chervonenkis (VC) dimension, VC generalization bounds, Sparsity in the context of high-dimensional data, the significance of sparsity, Sparsistency, Consistency, Persistency, Sparsity's role in nonparametric regression, Sparsity within graphical models, Greedy algorithms, Sparse linear regression, Compressed sensing, Nonparametric Methods: Nonparametric regression, Density estimation, Factor Analysis, Matrix Factorization, The bootstrap, Subsampling,. Nonparametric Bayesian approaches, Sparse Signal Processing, Topological Data Analysis, Deep Generative Models, Reinforcement Learning.

UNIT 4: **12 lecture hours**

Probability Distributions for modelling, Markov Networks, Hidden Markov Model, Advanced Theory including 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, Markov Chain Monte Carlo (MCMC) Methods, Causal Inference, Natural Language Processing (NLP), Time Series Analysis.

Laboratory:

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

Text Books:

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

Name of Program	Bachelor of Computer Applications

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))

BCA4104/ BCA4154	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)

By the end of this program, students should have the following knowledge, skills, and values:

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 Opportunities, 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, Behavioural 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 Book:

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

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 Elective I and 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))

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 Computer Applications				
BCAS401	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)

By the end of this program, students should have the following knowledge, skills, and values:

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: **7 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: **7 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: **7 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: **7 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. *J. Nedumaan, 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.*

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 Computer Applications				
BCAS402	Cognitive Modelling	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

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: **7 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: **7 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: **7 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, Subpersonal Model.

UNIT 4: **7 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.

Laboratory:

Implement Long Term Memory encoding approach. Implement Models of semantic memory. Implement Brain Signals and Feature extraction. Implement Neuroscientific Model. Psychological Model. Implement Representational Model. Multiple realizable Model. Implement Isomorphic Model. MultipleDraft Model. Implement Decision Making models. Implement Machine Learning algorithms for cognitive computing.

Implement Data Mining algorithms for cognitive computing. Implement Neural Networks algorithms for cognitive computing.

Text Book:

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

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 Computer Applications				
BCAS403	AI in Healthcare	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

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 make use of opportunities to leverage decision support in adapting to trends in the industry.

Course Contents:

UNIT 1: **6 lecture hours**

History of AI in Medicine, Evolution of AI in Medicine, AI's Contribution to Decision Support in Healthcare, Evaluating the Capacities and Constraints 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), Interoperability of Healthcare Systems, Global Perspectives on AI in Healthcare, Patient-Centric AI Applications.

UNIT 2: **7 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: **9 lecture hours**

Predictive modeling, Disease prediction, Early detection, Cancer detection using tabular data, Risk estimation in medical insurance, Medical Imaging, MRI, CT scan, X-Ray, 2D CNN, 3D CNN, Biomedical signals, Natural Language Processing (NLP) in Healthcare, Human-in-the-Loop AI for Medical Diagnosis, Explainable AI in Healthcare, Robotic Surgery Assistance, Computer Vision Systems for Physiotherapy, Large scale medical image retrieval, Handling hyper-dimensional medical images, Electronic phenotyping, Rule based phenotyping, Probabilistic phenotyping, DNA phenotyping, Multimodal data analysis, Regression analysis for Patient Monitoring and Preventive Screening. Case Study: Implementing regression analysis in AI models for continuous patient monitoring and preventive screening.

UNIT 4: **6 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. Predictive Analytics for Healthcare Resource Management, AI-Augmented Robotic Surgery, Case Studies: Utilizing computer vision and AI for analyzing and evaluating walking patterns, AI-based techniques for estimating the poses and movements of patients during medical examinations, Application of computer vision in monitoring and guiding physiotherapy exercises, Detection and analysis of patterns in the spread of infections using AI techniques, Recommender systems tailored to individual patient characteristics and medical history.

Laboratory:

Implementation of program to read tabular, textual, image, signal medical data in different formats. Implement sugar level and blood pressure prediction using regression modelling. Implement an early diabetic prediction system using classification modelling. Implement a insurance risk prediction system using EHR of patients. Implement a CNN based medical image classification system. Implement medical text classification system using statistical as well as deep learning- based word/text representation schemes. Implement a medicine recommender system using EHR of patients of a specific disease. Implement a patient clustering system for personalized medicine development. Implement a pandemic disease graph construction using publicly available data and perform graph related analytics operations. Implement CNN based pose estimation system for yoga pose recognition.

Text Book:

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

Name of Program	Bachelor of Computer Applications

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))

BCAS404	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)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: To articulate images using Histograms and spatial and image representation using textures.
CO2: To examine motion using optic flow, morphological operations, and compress images using lossless and lossy compression techniques.
CO3: To implement different low-level and high-level image and video processing techniques to a wide variety of applications.

Course Contents:

UNIT 1: **7 lecture hours**

Applications of Digital Image Processing, Elements of Digital image processing systems, Sampling and quantization, Neighbours 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: **7 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 the histogram, Texture from GLCM matrices, Motion Detection, Concept of Optical Flow, Optical flow equation, Lucas Kanade method.

UNIT 3: **7 lecture hours**

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: **7 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, Motion-compensated (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.

Laboratory:

The lab work will be based on image enhancement, image zooming, image cropping, image restoration, image compression and image segmentation etc. The Lab will use MATLAB and Open CV with python.

Text Books:

1. *Szeliski, Richard. Computer Vision: Algorithms and Applications (2 ed.), Springer, 2022. ISBN 978-3030343712.*
2. *Bhuyan, Manas Kamal. Computer Vision and Image Processing Fundamentals and Applications (1 ed.), Springer, 2021. ISBN 978-1351248383.*

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 Computer Applications				
BCAS405	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)

By the end of this program, students should have the following knowledge, skills, and values:

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, searchengine optimization, records compliance and risk management.
CO3: Implement different information retrieval approaches for applications in text domain.

Course Contents:

UNIT 1: **10 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: **8 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: **10 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.

Laboratory:

In this lab work, the students will implement problems based on search engines and common open-source software to perform common methods of exploratory and predictive analysis. The students also build application of text analysis techniques for data analysis.

Text Books:

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

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 Computer Applications				
BCAS406	Natural Language Processing	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

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: **7 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: **7 lecture hours**

iNLTK (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: **7 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: **7 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, OpenAI's GPT, Google's ALBERT, ULMFiT, Facebook's RoBERTa, Text Summarization, Extractive, Abstractive Text summarization, Transformer models for Text Summarization.

Laboratory:

Implementation of text document reading, parsing and applying text pre-processing approaches. Implement wordnet based document representation and word searching. Implement word level and sentence level text

representation for searching. Implement one hot vector of the given dataset (Indian language). Design first neural network for text processing. Implement topic modelling using clustering and LSA. Implement text classification model for sentiment analysis. Implement Part of Speech (POS) tagging and Named Entity Recognition (NER). Implement Machine Translation model. Implement chatbot using sequence to sequence modelling. Implement Text Generation models for social media, news context.

Text Book:

1. *Rao, Delip and Brian McMahan,, Natural Language Processing with PyTorch: Build Intelligent Language Applications Using Deep Learning (1st ed.), O'Reilly Media, 2019. ISBN 978-1491978238.*

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 Computer Applications				
BCAS407	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)

By the end of this program, students should have the following knowledge, skills, and values:

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: **7 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: **7 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: **7 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: **7 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.

Laboratory:

Students will learn a practical exposure to implement different probability concepts. The students will design and develop applications of probability for insurance, stock market prediction, gambling etc. During the lab works, students will be able to utilize programming and scientific tools for relevant probabilistic app design.

Text Book:

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

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 Computer Applications				
BCAS408	Reinforcement Learning	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: To articulate the key features of Reinforcement Learning (RL).
CO2: To examine the formulation, design, and implementation of the given application as RL problem.
CO3: To implement common RL algorithms and evaluate them using relevant metrics.

Course Contents:

UNIT 1: **6 lecture hours**

Reinforcement Learning (RL), RL vs ML, RL applications, Ethics in RL, Sequential Decision Making, Modelling the World, RL simulators, State, Action, Reward, Environment, Taxonomy of reinforcement learning agents, Fully vs partially observed environment, Markov Processes, Markov property, Markov chains, Markov Decision Processes (MDP), Markov Reward Process (MRP).

UNIT 2: **9 lecture hours**

Polices, Value Functions, Value based RL, Policy based RL, Bellman Equations, Exploration vs exploitation, Q Learning, Deep Q Networks (DQN), DDQN, Dueling DQN, Experience Replay, Bandit Algorithms, Online Learning, Optimality Proofs, Contextual Bandits, Dynamic Programming, Asynchronous Dynamic Programming.

UNIT 3: **7 lecture hours**

Policy-based Reinforcement Learning, Policy Gradients, Policy Evaluation (Prediction), Policy Improvement, Policy Iteration, Value Iteration, REINFORCE algorithm, Stochastic policy search, Actor-critic methods (A2C, A3C), Hierarchical Reinforcement Learning, Generalized Policy Iteration, Hierarchical RL: MAXQ, Monte Carlo Policy Gradients, Generalized Advantage Estimation (GAE), Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control.

UNIT 4: **6 lecture hours**

On-Policy Learning, Off-Policy Learning, Temporal Difference Prediction, Full RL, Reinforcement Learning in Continuous Spaces, State–action–reward–state– action (SARSA), Incremental Implementation, Policy optimization methods, Trust Region Policy Optimization (TRPO), Proximal Policy Optimization (PPO), Meta-learning, Multi-Agent Reinforcement Learning, Partially Observable Markov Decision Process.

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 Book:

1. *Sutton, Richard S. and Andrew G. Barto, Reinforcement Learning: An Introduction (2nd ed.), MIT Press, 2018. ISBN 978-0262039246.*

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 Computer Applications				
BCAS409	Special 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)

By the end of this program, students should have the following knowledge, skills, and values:

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 Artificial Intelligence.

Course Contents:

UNIT 1: **28 lecture hours**

This course covers the cutting-edge topics in Artificial Intelligence, and these modules will be chosen by the instructor based on the requirements and relevance at that point of time. These modules 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 modules.

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: Cloud Computing

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 Computer Applications				
BCAS410	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)

By the end of this program, students should have the following knowledge, skills, and values:

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: **10 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: **9 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: **9 lecture 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 Computer Applications				
BCAS411	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)

By the end of this program, students should have the following knowledge, skills, and values:

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: **9 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: **7 lecture 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.

Laboratory:

Studio work focuses on seven cloud sub domains that are as; 1. Monitoring and Reporting, 2. High 3. Availability, 4. Deployment and Provisioning, 5. Storage and Data Management 6. Security and Compliance, 7. Networking and Automation and Optimization.

Text Books:

1. *Digby, S. G., Fitch, C., Friedberg, S., Qualheim, S., Rhoads, J and Sundrud, B, AWS Certified SysOps Administrator Official Study Guide: Associate Exam (1st ed.), John Wiley & Sons, 2017. ISBN 9781119377429.*
2. *Rajasekharaiah, Chandra. Cloud-Based Microservices: Techniques, Challenges, and Solutions (1st ed.), Apress, 2020. ISBN 9781484265642.*

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 Computer Applications				
BCAS412	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)

By the end of this program, students should have the following knowledge, skills, and values:

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: **10 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: **11 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: **7 lecture 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.

Laboratory:

Learner will be able to examine Public Clouds Shared Responsibility Model, Identify the security and compliance benefits of using the AWS/Azure/GCP cloud, Describe the basic features for access control and management, Describe AWS/Azure/GCP data encryption methods, Describe AWS/Azure/GCP services used to protect network security, Describe the basic steps to ensure strong governance of your AWS resources, examine legal and regulatory issues related to cybersecurity.

Text Books:

1. *Lei, Chen, Hassan Takabi, and Nhien-An Le-Khac, Security, privacy, and digital forensics in the cloud (1st ed.), John Wiley & Sons, 2019. ISBN 13:9781119053286.*
2. *Brian, Russell, and Drew Van Duren, Practical Internet of Things Security: Design a security framework for an Internet connected ecosystem (2nd ed.), Packt Publishing Ltd, 2018. ISBN 13: 9781788625821.*

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 Computer Applications				
BCAS413	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)

By the end of this program, students should have the following knowledge, skills, and values:

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: **10 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: **11 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: **7 lecture 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.

Laboratory:

By performing lab work on AWS cloud platform, students will have the knowledge of the Design principles and best practices of the Reliability pillar, select compute, storage, database, and networking resources to improve performance, evaluate the most important performance metrics for your applications, follow best practices to eliminate unneeded costs or suboptimal resources, troubleshoot common errors.

Text Book:

1. *Ben, Piper and David Clinton, AWS Certified Solutions Architect Study Guide: Associate SAA-C02 Exam (1st ed.), John Wiley & Sons, 2020. ISBN 9781119138556.*

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 Computer Applications				
BCAS414	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)

By the end of this program, students should have the following knowledge, skills, and values:

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: **10 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: **10 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: **8 lecture 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 (1st 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 (2nd ed.), Packt Publishing Ltd,, 2019. ISBN 9781788398732.*

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 Computer Applications				
BCAS415	Cloud Infrastructure and Services	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: To articulate the building blocks of cloud infrastructure in the current industry scenario.

CO2: To design the cloud infrastructure using infrastructure as code.

CO3: To develop and deploy cloud services as per the cloud architectural use case.

Course Contents:

UNIT 1: **11 lecture hours**

Cloud Models, Cloud Migration, On-premises IT vs On-Cloud IT, Virtualization, Virtual Cluster Formation, Classic Data Centre (CDC), Virtualized Data Centre (VDC), Virtual Network devices, Compute Resource, Storage resource, Network clusters, Edge Location, Cloud infrastructure vs. cloud architecture, Defining Cloud Infrastructure, Design issues of cloud-based development and deployment, Software Development Life Cycle, Agile Methodology, DevOps Culture, CI/CD implementation of Infrastructure as a code, Cloud-Infrastructure cost estimation, Specifying the service level agreements, Publishing Cloud Resource Templates, Defining licensing models, Categories of Cloud Infrastructure, Data center Rack Management, Green Cloud computing, Ubiquitous clouds, Utility Computing, Cluster Computing, Grid Computing, Case Study of Edge Computing.

UNIT 2: **7 lecture hours**

Data Centre Management Tools Integration, Service and Resource Management, Infrastructure Security and compliances Case and Study, Designing Cloud Infrastructure template/code, Inter-cloud Resource Management & Demo, Interfaces for Users, Admins, and Developers, Service-oriented architecture (SOA), Services lifecycle management, Cloud APIs, Message-oriented Middleware, Workflow in SOA.

UNIT 3: **10 lecture hours**

Case Study: Cloud Infrastructure market analysis, Active Directory Concept, Demo of Active Directory, Microservices and its detailed programming model, Serverless Computing, Serverless Demo, Parallel and distributed programming paradigms, Coupling and Decoupling of Well-defined Architecture, Criteria for cloud service selection, Parameters affecting to performances of service implementation, Popular open sources DevOps tools, Case Study of DevOps Tools, Working with Container and Docker, Working with Kubernetes, Application Development and Deployment on Kubernetes, Continuous Integration and Continuous Development (CI-CD), Demo CI/CD pipeline, Everything is as a service: Case Studies.

Laboratory:

best practices of cloud infrastructure principles by integrating cloud services to make it scalable, reliable, and highly available. It also leverages CSP Managed Services to enable greater flexibility and resiliency in an infrastructure. In addition, lab works cover well-architected framework to optimized underlying cloud resources for any workload.

Text Books:

1. *Hurwitz, Judith S. and Daniel Kirsch, Cloud Computing for Dummies. Hoboken: John Wiley & Sons (2nd ed.), For Dummies, 2020. ISBN 9781119546658.*
2. *Rajasekharaiah, Chandra. Cloud-Based Microservices: Techniques, Challenges, and Solutions (1st ed.), ApAddison-Wesley Professionaress, 2020. ISBN 9781484265642.*

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 Computer Applications				
BCAS416	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)

By the end of this program, students should have the following knowledge, skills and values:
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: **5 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: **7 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: **9 lecture 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: **7 lecture 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).

Laboratory:
The lab work demonstrates orchestration tools like Docker, Swarm, and Kubernetes with hands-on experience of concepts taught in the lecture. Students will gain hands-on experience using real accounts on AWS, Azure, Google Cloud Platform.

Text Book:
1. *Mark Panthofer, Mastering Docker Enterprise: A companion guide for agile container adoption.*

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 Computer Applications				
BCAS417	Special Topics in Cloud Computing	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

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 Cloud Computing.

Course Contents:

UNIT 1: **28 lecture hours**

This course covers the cutting-edge topics in Cloud Computing, and these modules will be chosen by the instructor based on the requirements and relevance at that point of time. These modules 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 modules.

Laboratory:
Students will gain practical experience by using tools and technologies related to Cloud Computing.

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 & Analytics

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 Computer Applications				
BCAS418	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)

By the end of this program, students should have the following knowledge, skills, and values:

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: **8 lecture hours**

Digital Marketing, CRM, Affiliate Marketing, P-O-E-2 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: **6 lecture hours**

Online content, Content Creation, Types of Content, Content optimization, Content Management & Distribution, Recommendation system for e-commerce, User and User Item, Study of popular recommendation platforms, Market basket analysis, Predicting product adoption. Module 3 (7 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 3: **7 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.

Laboratory:

The lab component is meant to analyze e-commerce data and social media data through multiple analytics tools such as Google Analytics, Piwik, Kissmetrics, Crazy Egg, etc.

Text Books:

1. *Schneider, P Gary. 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.*

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 Computer Applications				
BCAS419	Structural Equation Modelling	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

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: **8 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: **6 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: **8 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: **6 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.

Laboratory:

Students will be doing Lab experiments using R/Python to implement various Techniques, algorithms and problems related to the respective modules.

Text Book:

1. *Thakkar, J Jitesh. Structural Equation Modelling: Application for Research and Practice (1st ed.), Springer, 2020. ISBN 978-9811537929.*

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 Computer Applications				
BCAS420	Time Series Analysis	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

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: **8 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: **7 lecture hours**

White noise model, Random walks, moving average, Invertibility, ARIMA Models, Autoregressive processes, Fitting an AR process, Yule–Walker equations, General linear process, World 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: **7 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: **6 lecture hours**

Gaussian Process, Gaussian Regression, Vector autoregression model's 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.

Laboratory:

The lab component is meant to perform time series analysis, time series forecasting with R, time series prediction with LSTM Recurrent Neural Networks by using Python with Keras etc.

Text Books:

1. *Nielsen, Aileen. Practical Time Series Analysis: Prediction with Statistics and Machine Learning (1st ed.), O'Reilly, 2019. ISBN 1492041653.*
2. *Mills, C Terence. Applied Time Series Analysis: A Practical Guide to Modelling and Forecasting (1st ed.), Academic Press, 2019. ISBN 978-0-12-813117-6.*

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 Computer Applications				
BCAS421	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)

By the end of this program, students should have the following knowledge, skills, and values:

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: **8 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: **7 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: **7 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. Module 4 (6 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.

Laboratory:
Students will work on DataSets to use the various features of tools to practice and understand the functionality. Students will be preparing a dashboard for Data Science Case study and will customize. Students will be required to understand the challenges to work on large datasets and will experiment with such challenges.

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.*

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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 Computer Applications				
BCAS422	Social Network Analysis	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

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: **8 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 colouring problem, Valued graphs, Multi graphs.

UNIT 2: **7 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: **7 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: **6 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.

Laboratory:

Implementing Random graph Models, finding cliques and Motifs, Exploring and analysing various tools like Tweet Reach, How Sociable, and Addict-o-matic to understand the latest concepts and advancements in social media analysis.

Text Books:

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

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 Computer Applications				
BCAS423	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)

By the end of this program, students should have the following knowledge, skills, and values:

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: **8 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: **6 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: **6 lecture hours**

Hadoop Ecosystem, Hadoop Overview, HDFS, Map-Reduce, Pig Overview, Pig Grunt Shell, Hive, HBase, Architecture of Hive and HBase.

UNIT 4: **8 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.

Laboratory:

Students will gain practical experience by using tools and technologies like R, HDFS, MapReduce, Hive, pig, NoSQL, tableau.

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.*

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 Computer Applications				
BCAS424	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)

By the end of this program, students should have the following knowledge, skills, and values:

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: **9 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: **6 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: **7 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: **6 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.

Laboratory:

Setting up of DDBMS environment, Implementation of a case study based on DDBMS, Implementation of a case study on Object Oriented designing approach, Working on On-Line Analytical Processing functions of Oracle, NoSQL tools like Riak, Cassandra, MongoDB and Neo4j.

Text Book:

1. *Patil, Soudamini, Narendra Joshi, Vrushali R. Sonar, Umesh 2. Patil, Yogesh B. Patil, and Rohit A. Kautkar, Advanced Database Management Systems (1st ed.), Technical Publications, 2020. ISBN 9789389180336.*

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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 Computer Applications				
BCAS425	Satellite Data Analysis	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: To explain the mechanisms of GIS and spatial data towards the preparation of thematic maps.
CO2: To examine and interpret various land features over satellite images.
CO3: To design and implement techniques for land feature recognition and image mosaicking.

Course Contents:

UNIT 1: **8 lecture hours**

GIS Data Representation, Geospatial data for GIS applications, Digital representation of geospatial data, Mapping, Paper based maps vs digital maps, Map scale, Cartography, Electromagnetic spectrum, Pre-processing of Satellite Images, Georeferencing, Image enhancement, Ground Control Points collection, Satellite Image Interpretation, Raster Based GIS, Raster representation of data grid size and resolution, Data capture/preparation, Raster to vector conversion, Vector based GIS, Vector representation of data, Spatial data Collection, Sampling, Scaling.

UNIT 2: **7 lecture hours**

GIS Data Representation, Geospatial data for GIS applications, Digital representation of geospatial data, Mapping, Paper based maps vs digital maps, Map scale, Cartography, Electromagnetic spectrum, Pre-processing of Satellite Images, Georeferencing, Image enhancement, Ground Control Points collection, Satellite Image Interpretation, Raster Based GIS, Raster representation of data grid size and resolution, Data capture/preparation, Raster to vector conversion, Vector based GIS, Vector representation of data, Spatial data Collection, Sampling, Scaling.

UNIT 3: **7 lecture hours**

Different types of resolutions in Remote Sensing, Image interpretation of different geological landforms, rock types and structures, Remote Sensing integration with GIS and GPS, SAR Technique and its applications, Hyperspectral Remote Sensing, Integrated RS and GIS, Limitations of Remote Sensing Techniques, 3- dimensional viewing of land features, Spatial maps and Geoservers, Image mosaicking, Keypoint Detection, Projective Layouts, Image interpretation.

UNIT 4: **6 lecture hours**

Onboard data handling in LandSat 8 and 9, Handling reflective bands, Handling thermal infrared bands, Liner adaptive contrasting, Non-linear adaptive contrasting (25), Hubble telescope images, Data Calibration and Pipeline reduction, Chandra X-ray Observatory, Processing False Color Images, 3-Color Composite Image Reduction, Google Earth Engine for large scale and multi-temporal data analysis (25) Limitations and future of satellite Image analysis.

Laboratory:

Reading and writing the individual Bands in satellite images, Pre-processing of Satellite Images, Generation of Natural color composite and False color composite images, Measurement from the orthorectified Satellite Images, Digitization, adding attribute information in spatial data, Computation of Various indices for vegetation and water estimation, Publishing spatial layers in Geoserver, Development of Web-GIS applications.

Text Book:

1. *Chang, K. T., Introduction to geographic information systems (9th ed.), McGraw-Hill Higher Education, 2019. ISBN 978-1260136371.*

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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 Computer Applications				
BCAS426	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)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: To articulate security threats in big data analytics.
CO2: To examine the system vulnerabilities, exploitation.
CO3: To implement defense mechanisms on big data analytics.

Course Contents:

UNIT 1: **9 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: **9 lecture hours**

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: **10 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.

Laboratory:

The studio work enables students to get recognize all security-related issues in Big Data systems, define cryptographic principles and mechanisms to manage access controls in the Big Data system and thwart privacy and security risks. In this laboratory, students will be learning of privacy-preserving techniques, security for Big data systems using various authentication and Encryption methods. Further, preventive and detective measures for Big data will be implemented using different access control mechanisms, audits and monitoring tools.

Text Book:

1. *Joshi, Ramesh C., and Brij B. Gupta. Security, Privacy, and Forensics Issues in Big Data Network Security Essentials (1st ed.), IGI Global, 2019. ISBN 978-1522597421.*

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 Computer Applications				
BCAS427	Special 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)

By the end of this program, students should have the following knowledge, skills, and values:

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 Data Science.

Course Contents:

UNIT 1: **28 lecture hours**

This course covers the cutting-edge topics in Data Science, and these modules will be chosen by the instructor based on the requirements and relevance at that point of time. These modules 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 modules.

Laboratory:

Students will gain practical experience by using tools and technologies related to MLDA.

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: Full Stack

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 Computer Applications				
BCAS428	Front-End UI Frameworks and Tools: Flutter and Django	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: To understand of UI design with flutter components.
CO2: To design the flutter app and understand Django.
CO3: To implement Flutter and Django components and libraries.

Course Contents:

UNIT 1: **6 lecture hours**

Basics of Flutter and Dart Programming, Dart Programming – Syntax: Variables, Data type, Dart conditional operators: If-else, For, while do-while Dart Functions: structure, return type, expression, OOP: classes, object, Methods, constructor, Inheritance, Abstract class, Flutter widgets: Scaffold, image, container, Icon, Flutter Layouts: card. Stateful and stateless widget, Navigation: button widget- floating raised, flat, dropdown, outline, Flutter Webview widget, Visual, Behavioral, and Motion-Rich Widgets, List View, Data View, Date Picker, Time Picker, Dialogs, alerts.

UNIT 2: **8 lecture hours**

Django structure, URL dispatcher Requests and Responses, GET and POST methods, MVC model and Generic Views, Images, Forms Alert Handling, Django REST, Generic Views in Django Rest, Building RESTful APIs, Database- Add tables, Dynamic progress bar Deploying Web APIs, Advanced Django for Web and Automation.

Laboratory:

In-studio work, students will learn that how to deploy Django REST Framework on different platforms and deploy Django Apps for various use cases.

Text Book:

1. *Zaccagnino, Carmine. Programming Flutter: Native, Cross-Platform Apps the Easy Way (The Pragmatic Programmers) (1 ed.), O'Reilly, 2022. ISBN 1680506951.*

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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 Computer Applications				
BCAS429	Front-End Web UI Frameworks and Tools: React Native	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills and values:

CO1: To understand of JavaScript, react and native components.
CO2: To design and display of web app and mobile app.
CO3: To implement native components and Plug-Ins.

Course Contents:

UNIT 1: **7 lecture hours**

Course handout assessment mechanism, Front end web development, JavaScript: Arrow Functions, React, spread operator, Default params, Let and const variables, React Components: State and Props, composing components, adding states, React Components: Lifecycle, Event handling, Intermediate React: Rendering lists, Form elements, Forms: Controlled, Uncontrolled, Functional Components. React Virtual DOM, The Flux Architecture, Redux, Redux form validation, Brief Representational State Transfer (REST).

UNIT 2: **7 lecture hours**

React native, Animation API, Components: Basic, Stateful, Stateless, Custom fonts, Component API, Higher-Order Components: Keys, Fragments, Constructor, Animations, HTTP Requests: Syntax, XMLHttpRequest, Web Socket with Socket.io, Images module: Image source, image path, Network image, Firebase integration, ReactNative ListView, Authentication in ReactNative Using Firebase, Layouts, ListView Navigators, Botton Navigation, Push Notifications: Simple and Navigation based.

Laboratory:

Studio work consists of React library for JavaScript based front-end application development. It uses of JavaScript ES6, JSX and React framework for building user interfaces in front-end application development. Developing web Applications using React is to be focused.

Text Books:

1. *Alex, Banks. and Eve Porcello, earning React: functional web development with React and Redux (1 ed.), O'Reilly Media, 2017. ISBN 9352135636.*
2. *Stefanov S, React: up & running: building web applications (1 ed.), O'Reilly Media, 2016. ISBN 1491931825.*

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Name of Program	Bachelor of Computer Applications				
BCAS430	Front-End Web UI Frameworks and Tools: Bootstrap	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills and values:

CO1: Develop responsive web pages using Bootstrap's grid system and components.
CO2: Customize and implement Bootstrap UI elements to enhance web design.
CO3: Apply Bootstrap jQuery plug-ins for interactive and dynamic web features.

Course Content:

UNIT 1: **16 lecture hours**

Responsiveness, Features of Bootstrap, Mobile-First Strategy, Setting up Environment, Bootstrap to Applications, Bootstrap Grid, Setting up Git, Apply Bootstrap Grid, Display responsive Images, Use readymade themes, Customize Bootstrap's components, Less, Variables, jQuery plug-in, Bootstrap Typography, Use Typography, Bootstrap Tables, Bootstrap Form Layout, Bootstrap Button, Images in different styles: Circle shape, Display text like muted and warning, Carets Classes, Hide or show the text in Bootstrap. Bootstrap Components: Advantages, Types, Glyphicons Component: Use, Navigation Pills & Tabs Components, Navbar Component, build a Responsive Navbar, Forms and Navbar controls, Navbar Position, Breadcrumb, Component, Pagination Component, Labels/Badge Components, Jumbotron / Page Header Components, Thumbnail Component, Alerts & Dismissible Alerts, Progress Bar, Media Objects Component, Use Media Objects Component, Bootstrap List Group Component, Bootstrap Panel Component.

UNIT 2: **12 lecture hours**

Bootstrap Plug-Ins, Use Bootstrap Plug-Ins, Transition Plug-in, Modal Dialog Box, Properties, Methods and Events of Model Dialog Box, Scrollspy Plug-In, Tab Plug-in, use Tab Plug-in, Drop Down Plug-in, Tooltip Plug-in, Use Button Plug-in, Methods and events of Tooltip Plug-in, Popover Plug-in, alert and Button Plug-ins, Collapse Plug-in: Properties, Collapse Plug-in: Methods, Events of Collapse Plug-in, Carousel Plug-in, Affix Plug-in.

Laboratory:

Studio work consists of UI Design and Prototyping using Front-End Web UI Frameworks and Tools of Bootstrap 4 and advanced CSS and JavaScript. Here, building responsive design and Bootstrap Grid System, Learning Git, and utilizing Bootstrap CSS Components for displaying content is also targeted.

Text Books:

1. *Chiaretta, Simone. Front-end Development with ASP. NET Core, Angular, and Bootstrap. John Wiley & Sons, 2018. ISBN 9781119243963.*
2. *Moreto, Silvio, Matt Lambert, Benjamin Jakobus, and Jason Marah. Bootstrap 4–Responsive Web Design. Packt Publishing Ltd, 2017. ISBN 9781785288876.*

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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 Computer Applications				
BCAS431	Server-Side Development Frameworks: Express and Spring	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: To articulate the Express which is a minimal and flexible Node.js web application framework that provides a robust set of features for web and mobile applications.
CO2: To examine server-side development of web applications using Spring framework using Java language.
CO3: To make use of the interaction with backend databases such as mongo dB, MySQL, PostgreSQL with Express and Spring applications.

Course Contents:

UNIT 1: **7 lecture hours**
Introduction to Full Stack Development, Server-side Development: Node, Node modules and the Node HTTP server, Third party modules: mongoose, angular, react, express, npx, npm, brew, http server usage and options, Express framework, REST (REpresentation State Transfer (REST)) API server with Express, Get, post, put, delete, Node server with Express, Postman for API Testing Automation, Mongo dB database.

UNIT 2: **7 lecture hours**
Interacting with MongoDB from a Node application, Install mongo dB using npm, Import mongo client, Connect to client, Query execution from script file (node sample.js), Mongo and Mongoose, authentication and session-based authentication, Npm express-session, Token-based authentication with the support of JSON web tokens and the Passport module, Modules: express, passport, jsonwebtoken, Fundamental concepts of Spring Core: Dependency Injection (DI) and Inversion of Control (IoC), Automated Java-Based Configuration: @Component, @Autowired, @ComponentScan, Constructor Injection, Field Injection, Setter Injection.

UNIT 3: **6 lecture hours**
Spring Core application with Maven, Using Eclipse, Contents of pom.xml, Spring Framework support for Model, Controller and View pattern Directory Structure of Spring MVC using Maven, Required Jar files or Maven Dependency, Entry of controller in the web.xml file, Define the bean in the xml file, Displaying the message in the JSP page, Java, Spring MVC, Spring Security, Algorithm, Hibernate, Maven, Mysql Integration Application, Java Persistence API (management of relational data in the Java applications) and Hibernate (Object-Relational Mapping (ORM)), JPA (javax.persistence), Hibernate (org.hibernate), JPA (EntityManagerFactory), Hibernate (SessionFactory), JPA (Java Persistence Query Language (JPQL)), Hibernate (Hibernate Query Language (HQL)).

UNIT 4: **8 lecture hours**
CRUD paradigm in java application, RESTful web service: Create (POST), Read (GET), Update (Put), Delete (DELETE), Basic PostgreSQL data storage and management capabilities [create a database, drop a

database, select database, select table, update a record, create a table, delete record, drop table, triggers, functions, insert the record, procedures, cursors], Spring SecurityBasics, Spring Security Features, Spring Security Authentication, Spring JDBCTemplate Introduction, RowMapper, Builder, Spring Boot, JDBCTemplate using Postman API Hands on Session.

Laboratory:

Studio work consists of server-side development using Express framework based on node.js, use REST API with Express to interact with backend server. To develop Java Spring web applications using MVC. Also learn to integrate both frameworks with databases such as mongo dB, MySQL and PostgreSQL.

Text Book:

1. *Greg Lim, Beginning Node.js, Express & MongoDB Development (1st ed.), Paperback, 2020. ISBN 9789811480281.*

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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 Computer Applications				
BCAS432	Web Development for Blockchain Applications	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: Apply web development technologies and paradigms for blockchain-based applications.
CO2: Develop blockchain-integrated applications using JavaScript, smart contracts, and APIs.
CO3: Build secure, full-stack blockchain applications using server-side tools, databases, and modern front-end frameworks.

Course Contents:

UNIT 1: **8 lecture hours**

Why Blockchain with Web Development, Technology stacks, HTML5 & CSS for blockchain-based web development, Chrome dev tools, Functional programming paradigm JavaScript inside a browser, Python data types and basics, communication with peers, building client and server, miner and wallet, building a socket communication utility. Use of Low Code, No Code Tools in the development.

UNIT 2: **6 lecture hours**

JavaScript enabled blockchain applications, compiling new JavaScript to the old one with webpack, Better CSS with webpack, Code organization in a project, Asynchronous JavaScript code for developing smart contracts, APIs for blockchain solutions.

UNIT 3: **8 lecture hours**

Overview of server-side options, Node JS environment for blockchain and its ecosystem JSON REST API Using Postman to debug API, Managing server-side application state, web3js for blockchain web applications. Databases and SQL (SQLite, PostgreSQL), data normalization, User authorization and authentication, allowing users to interact.

UNIT 4: **6 lecture hours**

Web security basics, not trusting your clients, why use HTTPS, integrating other software with the server, developing frontend with React, concept of single-page applications, managing client-side application state (Redux), overview of other client JS frameworks, development organization, using git, concept of continuous integration, configuring a production web server with Ubuntu.

Laboratory:

This studio work enables students to get practical knowledge on core technical components of blockchains and their overlap with the Web, such as: Blockchain APIs, such as JavaScript, Web3, React or REST APIs, Blockchain primitives such as transaction initiation, key signing, and wallet management. In addition, which focus on creating user-friendly decentralized applications. This can be done with the help of truffle IDE which provides means to compile and unit test smart contracts locally. It also facilitates users to deploy smart contracts over Blockchain network which has several accounts to interact with the smart contract.

Text Books

1. *Eric, Traub Earn. Blockchain Programming with JavaScript: Build your very own Blockchain and decentralized netwo (1 ed.), Packt Publishing Ltd. 2018. ISBN 978-1789618822.*

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Name of Program	Bachelor of Computer Applications				
BCAS433	Special Topics in Full Stack	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

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 Full Stack.

Course Contents:

UNIT 1: **28 lecture hours**

This course covers the cutting-edge topics in Full Stack, and these modules will be chosen by the instructor based on the requirements and relevance at that point of time. These modules 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 modules.

Laboratory:

Students will gain practical experience by using tools and technologies related to Full Stack.

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Professional Electives

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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 Computer Applications				
BCAP301	User Centered 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: Articulate appropriateness of potential design methods such as contextual design, prototyping, ideation given a problem setting.
CO2: Examine the issues and challenges to achieving a user-cantered design process.
CO3: Implement design methods at a basic level of competence: interviews, personas, storyboarding, sketching, and evaluation.

Course Contents:

UNIT 1: **8 lecture hours**

User Centred Analysis (UCA), Mental models, knowing how the user works, Learnability, User model vs System Model, Which UCA steps to perform, Obstacles of user-centred analysis, Return on Investment (ROI), Justifying the right process, Creating a Design Strategy: Components of a design strategy, Site strategy drives design strategy, Where to get strategy information, Mining existing documentation, Working with brand objectives, Design techniques: Sketching, Scenarios, Storyboards, Design patterns.

UNIT 2: **9 lecture hours**

Profiles and Personas, Value of profiles and Personas, User profiles, Task profiles, Environment profiles, Data gathering methods, Choosing the right method, Elements of field interview, Developing interview questions, Good and bad interview technique, Conducting a user observation. Complementary Data Gathering Methods: Value of complementary methods, Focus groups, User group meetings, Usability roundtables, Complementary Data Gathering Methods, Facilitated workshops, JAD sessions, Using surveys and other indirect methods, Online surveys, Using multiple methods.

UNIT 3: **11 lecture hours**

Primary Noun Architecture, Describing primary nouns, Primary noun views, Primary noun details, Primary nouns to navigation, Information Architecture, Costs of poor organization, Basic organization schemes, Hybrid schemes, Shallow vs. deep structures, Labelling systems, Information Architecture, Affinity diagrams, Card sorting techniques, Card sorting tools, Getting sign-off on the contract for design, Using concept sketches to drive out requirements, Setting usability criteria, Scenario and Task Analysis: The power of a scenario, Scenarios vs. use cases, Determining the level of detail, Scenarios driven priorities. Scenario and Task Analysis: Identifying functions and tasks, Common errors and challenges in task analysis, Characterizing the new task design, Primary Noun Architecture: Value of primary nouns, Identifying primary nouns, Domain Analysis, Requirement analysis.

Text Books:

1. *Lowdermilk Travis, User centred design: A Developers Guide (1 ed.), O'Reilly Media, 2013. ISBN 978-1449359805.*

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Name of Program	Bachelor of Computer Applications				
BCAP302	Secure Coding	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 secure programming philosophy, design principles, and its methods.
CO2: To examine typical mistakes done during programming and the methods of their handling.
CO3: To implement the typical threats in programming and understand concepts of implementing the secure codes.

Course Contents:

UNIT 1: **9 lecture hours**

Secure Programming, Robust vs. Secure Programming, Security Policies and Procedures, Checking Design and Implementation, Where to Look for Vulnerabilities, Classification of Security Flaws, Landwehr's Taxonomy, Fortify Taxonomy, Protection methods at different layers, PreDeCo matrix of software security. Input Validation in Programming, Improper Error and Exception Handling, Code Injection and Mitigation, Broken Authentication.

UNIT 2: **6 lecture hours**

Secure Programming Design Principles, Principle of Least Privilege, Fail-Safe Defaults, Principle of Economy of Mechanism, Principle of Complete Mediation, Separation of Privilege Principle, Principle of Open Design, Principle of Least Common Mechanism, Principle of Least Astonishment, Control Hijacking Attacks and Defences, Attacks Using Virtual Machines, Static and Dynamic Analysis, Language-based Security Models, Isolation Techniques.

UNIT 1: **13 lecture hours**

XML External Entity (XXE), Cross-Site Scripting (XSS), Insecure Deserialization, LFI (Local File Inclusion) and RFI (Remote File Inclusion) vulnerabilities, Unvalidated File Upload vulnerability, Buffer Overflow vulnerabilities, Client Side Security, JavaScript Security, Click Jacking, Ajax Security, HTML5 Security, Java Secure Socket Extension (JSSE), Common Coding Errors and Vulnerability, Automation and Testing for secure coding, Research Issues in Secure Coding.

Laboratory:

Lab experiments on JAVA and C/C++ to understand the threats and implement secure coding. Implementation of input validation, improper error and exception handling, code injection and the techniques of its mitigation, demonstration of Broken authentication, and different types of threats, e.g., XXE Attack, XSS software attack, insecure deserialization, and user-interface redress attack.

Text Books:

1. *Richardson T. and Thies C. N., Secure Software Design, Jones & Bartlett Learning (1 ed.), Jones & Bartlett, 2012. ISBN 978-1449626327.*

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Name of Program	Bachelor of Computer Applications				
BCAP303	Compiler Construction	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: **10 lecture hours**

Compiler, Code Analysis, Interpreter, Single Pass, Two pass, Multi Pass compiler, Preprocessor, Macros, Phases of compiler, Symbol table manager, Operations on symbol table, Error handling, Bootstrapping and cross compiler, Lexical Analysis, Tokens, Regular expression, Generation of lexical analysis from DFA, Syntax Analysis, Parser, Context Free Grammar, Conversion Rule for Ambigous To Unambigous Grammar, Non-Deterministic & Deterministic Grammar, Left Recursive And Right Recursive Grammar, Parsing: Top down and Bottom up, Backtracking and their automatic generation, LL (1) Parser, LR Parser, LR (0) items, SLR (1), LALR (1), Canonical Parsing.

UNIT 2: **9 lecture hours**

Error Analysis, Error Classification, Error detection, Error Detection in LL and LR parsers, Error recovery, Panic mode error recovery, Static semantic, Intermediate code generation, static semantic analyses in declaration processing, name, and scope analysis, S-attribute, Semantic analysis through S-attribute grammar, L-attribute, Type checking, Language features influencing run time memory management. Parameter passing mechanism, Division of memory into code, stack, heap and static, Activation record, Garbage collection, Code generation for expressions, issues in efficient code generation.

UNIT 3: **9 lecture hours**

Sethi Ullman algorithm, optimal code generation, Retargetable code generation, Code generation for control structures, Code Optimization, Local and global optimization, Control flow analysis, Data flow analysis, Global optimizations, Graph colouring in optimization, Live ranges of run time values.

Laboratory:

Construct a lexical analyzer using Flex. Construct a parser using Prison Bison. Build simple compilers from parsing to intermediate representation to code generation and simple optimization.

Text Books:

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

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Name of Program	Bachelor of Computer Applications				
BCAP304	Software Project Management	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 and determine the purpose and importance of basic processes involved in project management from the perspectives of planning, tracking and completion of project.
CO2: To examine different organization structures and project structures.
CO3: To implement programs to manage project management, project schedule, expenses and resources with the applications of project management tools.

Course Contents:

UNIT 1: **10 lecture hours**

Project Management: Characteristics of software projects, Objectives, Stakeholders, Feasibility Study, Cost-benefit Analysis, Planning, Project Execution, Project and Product Life Cycles, Role of project manager, Knowledge areas, Tools & Techniques, System view of project management, Agile software, Iterative steps for planning, Project Plan documentation methods, Software Requirement Specification, Measurement and Control, Reviews, feedback and reporting mechanisms, revisiting the plan, Scope Planning & Scope management plans, Function point calculation, Scope definitions & project scope statement, Project time management, Activities sequencing, Network diagrams, Activity recourse estimation, Activity duration estimation, Schedule development, Gantt Charts, Critical path method, Program evaluation & review technique (PERT) and CPM, Principles of cost management, Cost estimating, Type of cost estimate, Cost estimate tools & techniques, COCOMO.

UNIT 2: **7 lecture hours**

Putnam/SLIM model Estimating by Analogy, Cost budgeting, Cost control, Earned value management, Project portfolio management, Project Quality Planning, Quality Assurance, Quality control, Tool & techniques for quality control, Pareto Analysis, Six Sigma, CMM, ISO Standards, Juran Methodology, Project Human resource planning, Project organisational charts, Responsibility assignment metrics, Acquiring project team, Resource assignment, resource loading, Resource levelling, Team structures, Project Communication Planning, Performance reporting, Managing stakeholders.

UNIT 3: **11 lecture hours**

Project Risk Management planning, Common sources of risk, Risk identification techniques, Qualitative risk analysis, Expert judgement, Decision trees, Expected monetary value, Simulation, sensitivity analysis, Risk response planning, Risk monitoring & control, Project Procurement management plans, Contract statement of work. Planning contracts, Requesting seller responses, Selecting sellers, Administrating the contract, Closing the contract, Software Configuration Management, Retaining versions, Software Configuration elements (SCI's), Change Control and Management.

Laboratory:

Using Function Point calculation tools for estimation, comparing with COCOMO estimates, Implementation of various exercises using PERT, CPM methods, preparing schedule, resource allocation etc. using MS Project or Fissure. sim or VENSIM or Visual Paradigm can also be used, Preparing an RMMM Plan for a case study, Preparing Project Plan for a Software Project for Lab Project or case study. Exploring about PMBOK (Project Management Body of Knowledge) and SWEBOK (Software Engineering Body of Knowledge) from related website, Implementation of software project management concepts using related tools and technologies.

Text Book:

1. *Roger Pressman and Bruce Maxim, Software Engineering: A practitioner's approach (9 ed.), Tata McGraw Hill, 2020. ISBN 978-1259872976.*

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Name of Program	Bachelor of Computer Applications				
BCAP305	Soft 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 comprehend the fuzzy logic and the concept of fuzzy set theory in soft computing.
CO2: To examine Neuro-Fuzzy and Genetic Algorithm expert system.
CO3: To implement applications on different soft computing techniques like Fuzzy, Multi Objective optimization and Genetic Algorithm (GA).

Course Contents:

UNIT 1: **7 lecture hours**

Soft Computing, Key characteristics and applications of soft computing, Soft vs. Hard computing, Fuzzy logic, Fuzzy set, Crisp vs. Fuzzy Set, Fuzzy Set Properties, Operations on Fuzzy set: Union, Intersection, Complement, Sum and Difference, Equality and Power, Cartesian Product, Fuzzy If Then Rules – Fuzzy Reasoning, Fuzzy membership functions, Gaussian membership function, Sigmoid membership function, Triangular membership function, Trapezoidal membership function, Fuzzy proposition, Fuzzy interferences, Fuzzy relations- Max-Min Approach, Fuzzification – Defuzzification, Fuzzy Logic Controller, Neuro-Fuzzy modelling.

UNIT 2: **7 lecture hours**

Multi Objective Optimization, Multi-Objective Evolutionary Algorithm, Pareto based Approach, Non-Pareto based approaches, Genetic Algorithm (GA), GA working architecture, Genetic representations, GA Encoding and Selection Techniques, Survival of the Fittest, Fitness Computations, GA Crossover Techniques, GA Mutation, Reproduction, Rank method, Rank space method, GA Case Studies: Optimisation of traveling salesman problem using Genetic Algorithm, Genetic algorithm-based Internet Search Techniques.

UNIT 3: **11 lecture hours**

Evolutionary Algorithm, Ant system, Ant Colony Optimization, Max-Min Ant System, Ant Miner, Snake-Ant Algorithm, Particle Swarm Optimization, Artificial Bee Colony, Cuckoo Search Algorithm, Working architecture, Co-evolution, Plasticity and life-time learning, Lamarckian learning, "No free lunch" theorem, Hybrid fuzzy controller, Fuzzy Logic Controlled Genetic Algorithms.

UNIT 4: **6 lecture hours**

Genetic Algorithms–Neural Networks, Neural Networks Fuzzy Logic, Extreme Learning Machine, Training SLFN using ELM, Extreme Learning Machine, Variants of ELM, Applications of ELM, Extended ELM.

Laboratory:

Fuzzy Logic, Multi Objective Optimization, GA, and hybrid fuzzy controller, implementation on MATLAB/PYTHONs.

Text Books:

1. *Saroj Kaushik and Sunita Tiwari, Soft Computing, Fundamentals, Techniques and Applications (1 ed.), McGraw-Hill Education, 2018. ISBN 978-9353160678.*
2. *Sivanandam, S. N., and Deepa, S. N, Principles of soft computing (1 ed.), John Wiley & Sons, 2011. ISBN 978-8126527410.*

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Name of Program	Bachelor of Computer Applications				
BCAP306	Distributed 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 models, architectures, and the concept of virtual clock and clock synchronization.

CO2: To examine the algorithms for mutual exclusion, deadlock detections, and termination detection.

CO3: To implementing the concepts of distributed computing on Google File System , Hadoop Distributed File System (HDFS), and sensor networks.

Course Contents:

UNIT 1: **8 lecture hours**

Introduction, process communication, Message Passing, Leader Election, Leader election algorithm, Distributed Models, Causality and Logical Time, Size of Vector Clock, Matrix Clocks, Virtual Time and Physical Clock Synchronization, Global State and Snapshot Recording Algorithms, Distributed Mutual Exclusion and Non-Token based Approaches, Quorum Based Distributed Mutual Exclusion Approaches: Maekawa's Algorithm.

UNIT 2: **7 lecture hours**

Distributed Mutual Exclusion-Token based approaches, Consensus & Agreement, Check pointing & Rollback Recovery, Deadlock Detection in Distributed Systems, Approaches, Algorithms for deadlock detection: Path-Pushing, Edge Chasing, Diffusion Compution, and Global state detection Distributed Shared Memory, Features and advantage, Distributed Minimum Spanning Tree.

UNIT 3: **7 lecture hours**

Termination Detection, Huang's algorithm, Message Ordering & Group Communication, Fault Tolerance and Self-Stabilization, Distributed Randomized Algorithms, Distributed Hash Tables and Peer to Peer Computing.

UNIT 4: **6 lecture hours**

Case Studies: Google File System and HDFS, Distributed Execution using Map Reduce, Introduction to Spark, Introduction to Sensor Networks, Distributed Algorithms for Sensor Networks: Coverage and Connectivity, Topology Discovery, LEACH – Cluster based Low Power Algorithm, Authentication in Distributed Systems, Security in Distributed Systems and Block Chain.

Laboratory:

In this course lab students will be working on Linux and execute experiments based on client server and socket programming, Algorithms for clock synchronization: Berklay clock and Lamport clock, Mutual Exclusion: token based and centralized algorithm, Election algorithm for wireless network, Hadoop and Map Reduce, simulation and security of wireless sensor network.

Text Book:

1. *Van Steen Maarten and Tanenbaum Andrew S., Distributed Systems (3 ed.), Amazon Digital Services, 2017. ISBN 978-1543057386.*

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

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Name of Program	Bachelor of Computer Applications				
BCAP307	Agile Software 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 existing problem with the team, development process, and wider organization.
CO2: To specify the most appropriate way to improve the results for a specific need using agile techniques.
CO3: To apply understanding of agile principles and specific practices.

Course Contents:

UNIT 1: **7 lecture hours**

Agile mindset, Agile manifesto, Predictive model, adaptive model, Agile principles, Organizational impact of adopting agile, Agile case study, Agile requirements, User stories and acceptance criteria, 3 C's in user stories.

UNIT 2: **9 lecture hours**

Epics and tasks, Product backlog and refinement, Scrum framework, Roles in scrum, Phases in scrum, Sprints, Sprint backlog, Daily scrum, Scrum rules, Agile estimation and planning, Effectively using story points, Need of velocity and duration, Planning poker technique for PBI sizing, Fixed estimation based on velocity, Velocity range, Release planning, Fixed scope release, Fixed date release, Agile and DevOps.

UNIT 3: **12 lecture hours**

Sprint planning, Capacity determination, Sprint Execution, Flow management, Swarming in flow management, Task board and task table, Sprint charts, Sprint review, Pre-work, process, and activities, Sprint retrospective, Participants, pre-work, process, and activities, Sprint retrospective steps, Extreme Programming (XP) in agile, XP values, XP practices, XP process model, Scrum vs XP.

Laboratory:

Analyzing various agile tools, Agile requirements - creating epics and activities, User story mapping, Kanban Board and Daily Standup Board, JIRA project with Kanban board, Configure Kanban board in JIRA, Create a scrum project JIRA, JIRA - Quick Search, Basic Search, and JQL, Filters in JIRA, Issue types in JIRA, Applying scrum framework using JIRA for capstone project.

Text Book:

1. *Craig Larman and Bas Vodde, Large-Scale Scrum: More with LeSS (1 ed.), Addison-Wesley Professional, 2016. ISBN 978-032198571286.*

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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 Computer Applications				
BCAP308	Virtual Reality: Interface, Application and 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 demonstrate an understanding of fundamental techniques, processes, technologies, and equipment used in immersive virtual reality.
CO2: To explore the materials and processes used in immersive virtual reality.
CO3: To show a basic awareness and understanding of historical and theoretical contexts relevant to immersive virtual reality and demonstrate an understanding of the importance of critical and self-reflective practice.

Course Contents:

UNIT 1: **8 lecture hours**

VR Goals and definitions, Historical perspective, Birds-eye view, Geometry of Virtual Worlds, Geometric modelling, transforming models, Matrix algebra and 2D rotations, 3D rotations and yaw, pitch, and roll, Axis-angle representations, Quaternions, Converting and multiplying rotations, Homogeneous transforms, the chain of viewing transforms, Eye transforms, Canonical view transform, Viewport transform. Hardware Technologies for 3D user Interfaces: Visual Displays Auditory Displays, Haptic Displays, Choosing Output Devices for 3D User Interfaces.3D user Interface Input hardware: Input device characteristics, Desktop input devices, Tracking Devices, 3D Mice, Special Purpose Input Devices, Direct Human Input, Home - Brewed Input Devices, Choosing Input Devices for 3D Interfaces.

UNIT 2: **8 lecture hours**

Light and Optics: Three interpretations of light, Refraction, Simple lenses, Dioptres, Imaging properties of lenses, Imaging properties of lenses, Lens aberrations, Optical system of eyes. Visual Physiology: Photoreceptors, Enough resolution for VR, Light intensity, Eye movements, Eye movement issues for VR, Neuroscience of vision. Visual Perception: Depth perception, Motion perception, Frame rates and displays.

UNIT 3: **8 lecture hours**

Tracking Systems: Orientation tracking, Tilt drift correction, Yaw drift correction, Tracking with a camera, Perspective n-point problem, Filtering, Lighthouse approach. Visual Rendering: Visual Rendering-overview, Shading models, Rasterization, Pixel shading, VR-specific problems, Distortion shading, Post-rendering image war.

UNIT 4: **4 lecture hours**

Physics and physiology, Auditory perception, Auditory localization, Rendering, Spatialization and display, Combining other senses. Interfaces: Interfaces -overview, Locomotion, Manipulation, System control, Social interaction, Evaluation of VR Systems.

Laboratory:

The laboratory of virtual reality is designed to provide a practical exposure to the students about the concepts and topics taught in the classroom sessions. Implementing the learnt concepts using Python will help the students to have a better understanding of the subject. 3D Modelling and surfacing, Bill Fleming, Elsevier (Morgan Ka VR Programming-I: Introducing Java 3D, loading and manipulating external models, using a lathe to make shapes, Programming-II: 3D Sprites, animated 3D sprites, particle systems.

Text Books:

1. *William R. Sherman and Alan Craig, Understanding Virtual Reality, Interface, Application and Design (2 ed.), Morgan Kaufmann, 2018. ISBN 978-0128183991.*
2. *Josh Gregory, Minecraft Virtual Reality (1 ed.), Cherry Lake Publishing, 2018. ISBN 978-1534129917.*

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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 Computer Applications				
BCAP309	Combinatorics	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 knowledge of combinatorics, numbers, and probability theory.
CO2: To articulate combinatorial problems, extract and interpret descriptive statistics from social networks, search engine and hypergraphs.
CO3: To implement and design various quantitative properties of large combinatorial structure.

Course Contents:

UNIT 1: **8 lecture hours**

Combinatorics, Counting and product principle, Counting over counting and sum principle, Function and bijection principle, Relations and equivalence principle, Pigeonhole principle, Subsets, Partitions, Subsets of fixed size, Subset of multiset, Subset of combination, Binomial theorem and Pascal's triangle, Binomial Coefficients, Congruences, Congruence of binomial coefficients, Permutations, One-line notation, Two-line notation, Canonical cycle notation, Estimates for factorials, Stirling's Approximation, Ramanujan's factorial approximation, Selections, Equivalence and order, Finite topologies, 0 or 1 points, 2 points.

UNIT 2: **7 lecture hours**

Compactness and countability, Connectivity, Separation axioms, Cayley's Theorem on trees, Algebraic topology, Generating Combinatorial Objects, Generating Subsets, Variable Size Decrease Algorithms, PageRank (PgRk) algorithm for searching engine, Kernel Networks for pattern analysis, Partially ordered sets or Posets, Graded poset, Lattices, Metroid, Linear extensions of posets, Distributive lattices, Propositional logic, Chains and antichains, Products and dimensions.

UNIT 3: **7 lecture hours**

Mobius function of poset, Famous Number Families, Multinomial Coefficients, Fibonacci Numbers, Lucas Numbers, Stirling Numbers, Integer Partition Numbers, Bell numbers, Recurrence Relation and Generating Functions, First order recurrence relation, Second order recurrence relation, Non- homogeneous recurrence relation.

UNIT 4: **6 lecture hours**

Combinatorics on graphs, Infinite Combinatorics and Graphs, Counting trees, Minimal spanning Trees, Chromatic polynomial, Manifold method for non-linear dimensionality reduction, Spectral methods to solve differential equations, Turan Problem, Littlewood-Offord Problem, Catalans Numbers, Isoperimetric Problems.

Text Book:

1. *Bona M Miklos, A Walk-Through Combinatorics: An Introduction to Enumeration and Graph Theory(4th ed.), WSPC, 2016. ISBN 978-9813148840.*

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Name of Program	Bachelor of Computer Applications				
BCAP310	Mobile and Networked Embedded Systems	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 and networked embedded systems.
CO2: To explain the architecture of networked embedded systems.
CO3: To design and develop networking systems for automated applications for smart cities, building, parking.

Course Contents:

UNIT 1: **12 lecture hours**

Smart Environments, Paradigms for pervasive networking, Networked Embedded Systems, Wireless Embedded Networking, Applications, Network Topology, Real-time embedded systems, Components of networked embedded systems, Centralized and distributed embedded systems, Physical sensor, Passive sensor, Semi-passive, Active sensors, Soft sensors, Sensor nodes, Hardware architecture. Operating systems for sensor nodes, Mobile sensor network, Sensor networks with mobile nodes.

UNIT 2: **8 lecture hours**

Power management and mobile node discovery, Data transfer to mobile nodes, Routing to mobile nodes, Sensor networks with all mobile nodes, Participatory sensing, Vehicular Networked Embedded Systems, Embedded Networks for Car Domains, Intra -vehicular Network Embedded Systems, Event Triggered Systems, Time Triggered Systems, Inter-Vehicular Network Embedded Systems.

UNIT 3: **8 lecture hours**

Applications for smart cities (pollution monitoring), Applications for smart cities (smart lighting, context-aware applications), Smart mobility (parking area management), Smart mobility (intelligent transportation systems), Smart buildings (home/building automation, energy efficiency), Social sensing applications.

Text Book:

1. *Chattopadhyay S., Embedded System and Design (2nd ed.), Prentice Hall India Learning Private Limited, 2013. ISBN 978-8120347304.*

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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 Computer Applications				
BCAP311	Problem Solving using C	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 various concepts in C programming language and understand the problem-solving aspect.

CO2: To Implement concept of pointer and perform I/O operations in files and make use of concepts in finding solutions to real-life problems.

Course Contents:

UNIT 1: **8 lecture hours**

Program structure, Communications with the Operating System, Library Functions, Pre-processor Directives, Debugging and Efficiency, Memory Models, Data Types-Simple C data types, Integer Data types, Floating Point types, Derived Data types, The ASCII Character Set, Compilation and Linking, Types of compilers, Decision making, Loops, Switch statement, Goto statement, Null statement, Comma operator, setjmp functions, longjmp functions, Storage classes: automatic variable, external, static, register, Arrays, Array Indexing, Using Array names as Pointers, Character Arrays.

UNIT 2: **10 lecture hours**

Advanced data types: #define statement, Variable length array, Flexible array members, Complex number type, Type Qualifiers: Const, Volatile, Restrict, Functions, Pass by value, Pass by reference, Command Line Arguments, Structures, Arrays of Structures, Structures of Arrays, Structures of Structures, Bit Fields in Structures, offsetof(), Macro, unions, Typedef, Typecasting, Implicit type casting, Explicit typecasting, Pointers- Declaration, NULL pointers, Indirection, Pointer to array, Pointer to function, Pointer to structure, Arrays of Pointers, Passing pointers to functions.

UNIT 3: **10 lecture hours**

File handling, Recursive functions, Memory allocation in a recursive method, Dynamic memory allocation, Global Memory versus Local Memory, Error handling in C, Global Variable Errno, perror() and strerror(), Exit status, Divide by zero errors, Interfacing C with Python code: Calling C functions from Python, Calling python functions from C, Threads: Creating a thread, Passing arguments and returning values, Common thread functions, Thread synchronization concepts, Mutexes, condition variables.

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.

Text Book:

1. *Gottfried Byron, Outline of Programming with C (4th ed.), McGraw Hill Education, 2018. ISBN 978-0070145900.*

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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 Computer Applications				
BCAP312	Programming using C++	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 fundamental programming concepts and methodologies to building C++ programs.

CO2: To implement various OOPs concepts including memory allocation/deallocation procedures and Member functions.

Course Contents:

UNIT 1: **9 lecture hours**

Principles of Object-Oriented Programming, data types, Symbolic constants, Reference by variables, Operators, Operator precedence, Control structures, If-else, Nested If, Switch, break, continue, Functions, main function, Function prototyping, Call by reference, Return by reference, Inline function, Default arguments, Function overloading, Defining a class and member functions, Private member functions, Nesting of member functions.

UNIT 2: **11 lecture hours**

Arrays within a class, Arrays of objects, Memory allocation, Static data members, Static member functions, Friendly functions, Objects as function arguments, Returning Objects, Constructors, Default constructor, Parameterized constructor, Copy constructor, Multiple constructors, Constructors with default arguments, Dynamic constructor, Destructors, Rules for overloading, Operator overloading, Unary and binary operator overloading, Overloading using friends, Type conversion, Inheritance, Defining derived classes, Visibility modes, Single inheritance, Multilevel inheritance, Multiple inheritance, Hierarchical inheritance, Hybrid inheritance, Runtime Polymorphism

UNIT 3: **8 lecture hours**

Virtual base classes, Abstract classes, File Handling, Throwing Mechanism, Caching Mechanism, Rethrowing an Exception, Constructors in derived classes, Nesting of classes, Exception Handling, Opening and closing a file, Detecting End-of-file, Sequential input and output operations, Generic Programming using template, Class template, Function template, Class member function template, Function overloading, Standard Template Library: Containers, Stack, List, Queue, Algorithms, Iterators.

Laboratory:

This lab to implement various OOPs concepts including memory allocation/deallocation procedures and Member functions. This course lab is to strengthen problem solving ability by using object- oriented approach and to design applications using object-oriented concepts.

Text Books:

1. *Bjarne Stroustrup, The C++ Programming Language. (4th ed.), Addison-Wesley Professional, 2013. ISBN 978-0321563842.*
2. *E. Balagurusamy, Object Oriented Programming with C++ (1st ed.), Tata McGraw Education Hill, 2013. ISBN 978-1259029936.*

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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 Computer Applications				
BCAP313	Deep 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: 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: **7 lecture hours**

Why Deep Learning?, Machine Learning: features, weights, Artificial Neural Network, loss function, cost function, ANN: forward propagation; Backpropagation, Stochastic Gradient Descent, Batch gradient descent, mini batch gradient descent, Optimizers: Momentum, RMSProp, Adam, Deep Learning Experiments: Datasets, training-validation testing set, evaluation measures: accuracy, precision, recall, f-measure, Model Improvement: Overfitting vs underfitting, Bias vs Variance, Regularization: L1, L2 regularization, Dropout, Early stopping, Data normalization, Batch normalization, Hyper parameter Tuning: random, coarse to fine, Network architecture search.

UNIT 2: **11 lecture hours**

Data Augmentation in image: Cropping, Flipping, Rotation, Brightness, Contrast, Color Augmentation, Saturation, Convolutional Neural Networks: convolution, striding, padding, pooling, Alexnet Architecture, Image classification (ImageNet Challenge), Well known CNN architectures VGG16&19, Residual Block, Resnet50, 1x1 convolution, XceptionNet, EfficientNet, Transfer learning, Object Detection: setup problem and cost function, well known datasets, Evaluation measure: Average precision, Mean average precession, Two stage detector, single stage detector, RCNN, Fast RCNN, Faster RCNN, SSD, YOLO1-4, RetinaNet, EfficientDet, Image Segmentation: setup problem and cost function, various dataset, Semantic segmentation, Instance segmentation, Evaluation measure: IoU/Jacard Index, Dice score, Mean pixel accuracy, Segnet, Unet, Mask R-CNN.

UNIT 3: **10 lecture hours**

Generative Learning, Variational Auto-encoders, Generative Adversarial Neural Networks, GL Applications: Image generation, font generation, video generation, anime face/celebrity face generation, Deep Reinforcement Learning, Markov decision Processing, Deep Q Learning, Exploration vs Exploitation, Value Iteration vs Policy Iteration, RL Applications: Robotics, gaming, Ad Targeting, recommendation system, decision making, Model optimization for Deployment, Pruning, Quantization and binarization, Transferred or Compact Convolutional Filters, Knowledge distillation.

Laboratory:

Aim of this lab is to focus on gathering, pre-processing tabular, visual, textual and audio data for building deep learning models using standard Python libraries. To train, improve, and deploy deep learning models in different devices. To analyse performance of different deep learning models using speed, accuracy, size trade-offs.

Text Book:

1. *Ian Goodfellow, Yoshua Bengio, Aaron Courville and Yoshua Bengio, Deep learning. Vol. 1. C (1st ed.), ambridge: MIT press, 2016. ISBN 978- 0262035613.*

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Name of Program	Bachelor of Computer Applications				
BCAP314	Bioinformatics and Computational Genomics	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 knowledge of Bioinformatics, Computational Biology, and Genomics.
CO2: Implement algorithms and programs related to sequence database, search and alignments, gene prediction and homology.

Course Contents:

UNIT 1: **10 lecture hours**

D-, R-, Proteins, Splicing, Gene structure, Medicine as a Data-Driven Science, Human Genome Project, Biomedical Data, Exact Sequence Searches: Z-algorithms, Knuth-Morris, Boyer-Moore, Rabin-Karp, Sequence Analysis: Pairwise Sequence Alignment, Homology, Sequence alignment with Dynamic Programming, Extensions of Pairwise Sequence Alignment, Phylogenetic Tree Reconstruction, Biological and Molecular Databases, BLAST Search Engine, Human Variation Databases and Genome Viewers.

UNIT 2: **8 lecture hours**

Markov chain, Hidden Markov Model, Viterbi Algorithm, Forward Backward algorithm, HMM for motif finding, Advanced alignment techniques: Linear space, Affine gaps, Banded linear time alignments, Time warping, Burrow Wheeler Index, Next Generation Sequencing, Comparative genomics, Micro arrays, Shotgun sequencing, BAC to BAC sequencing, Phylogeny, Fitch algorithm.

UNIT 3: **10 lecture hours**

Multiple sequence alignment, MSA algorithms, Progressive alignment, CLUSTALW, Expectation Maximization, Gibbs Sampling, Genetic Algorithm, Clustering with a Genetic Algorithm, System Biology: Network Analysis, Rational Drug Design, Biomarkers, Human Genomic Variations, Monogenic Diseases, Complex Diseases, Genetic Predisposition to Cancer, Cancer Immunotherapy.

Laboratory:

Implementing few important algorithms in the field of Genomics: Viterbi Algorithm, BLAST Algorithm. Pattern Matching Algorithms: Rabin Karp and Knuth Morris Algorithm.

Text Books:

1. *Altuna Akalin, Vedran Franke, Bora Uyar and Jonathan Ronen, Computational Genomics with R (1st ed.), CRC Press, 2020. ISBN 978- 1498781855.*
2. *Baxevanis A. D., Wishart D. S., Bader G. D., Bioinformatics (4th ed.), Wiley, 2020. ISBN 978-1119335580.*

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Name of Program	**Bachelor of Computer Applications**				
BCAP315	**Special Topics in Computer 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: 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 Science.

Course Contents:

UNIT 1: **28 lecture hours**

This course covers the cutting-edge topics in Computer Science, and these modules will be chosen by the instructor based on the requirements and relevance at that point of time. These modules 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 modules.

Laboratory:

Students will gain practical experience by using tools and technologies related to Computer Science.

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Name of Program	Bachelor of Computer Applications				
BCAP316	Advanced Microprocessor	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 functionality of Von Neumann architecture to design advanced microprocessors systems.
CO2: Familiarize with the internal structure of motherboard and its components.
CO3: Design and use new interface techniques principle to access the peripherals.

Course Contents:

UNIT 1: **8 lecture hours**
Introduction: Basics of Von Neumann Architecture and the early Microprocessors, CISC and RISC concepts.

UNIT 2: **8 lecture hours**
Parallelism in Processor Architecture: Pipelining, Super-scalar, Super-pipeline and VLIW Architectures, Low-power Architecture; Built-in Multiprocessing support; Co-processors.

UNIT 3: **6 lecture hours**
Processor Architecture with hierarchical memory organization: Cache memory, Virtual memory; Built-in Multi-user and multitasking support in 16-bit and 32-bit microprocessors, Built-in memory mapping and management support; Evolution of platform architecture.

UNIT 4: **4 lecture hours**
Special-purpose processor Architectures: Signal processing Microprocessors; Communication processors; Case studies with contemporary Microprocessors.

Laboratory:

In lab students will perform experiments in assembly language. Students will implement code for RISC and CISC architecture, they also write code to perform parallelism in processor architecture pipelining, super-scalar, super-pipeline. They can create application specific processor from scratch as project.

Text Books:

1. *D. V. Hall, Microprocessor and Interfacing Programming and Hardware (2 ed.), McGraw Hill, 1991. ISBN 978-0070257429.*

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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 Computer Applications				
BCAP317	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: Understand about IoT overview including requirements.
CO2: Learn IoT related protocols and specifications.
CO3: Develop a project of IoT mock-up application of their own.

Course Contents:

UNIT 1: **8 lecture hours**

Overview of WSN, IoT, IoT Conceptual Framework, IoT Architectural View, Technology Behind IoT, Sources of IoT, M2M Communication. IoT/M2M Systems Layers and Design Standardization, Communication Technologies, Data Enrichment, Data Consolidation and Device Management at Gateway. Examples of IoT, Ease of Designing and Affordability. Use Case Studies: Smart Home, Smart City, Precision Agriculture.

UNIT 2: **7 lecture hours**

Sensing the Real-world using Analog and Digital Sensors, Industrial IoT, Automotive IoT, Actuator, RFID Technology – Principles, Architecture, Applications & Components, Web of Things of RFIDs. Cloud computing Paradigm for Data Collection, Storage and Computing, Everything as a Service and Cloud Service Models for IoT.

UNIT 3: **8 lecture hours**

Introduction, Web Communication Protocols: Constrained Applications Protocol (CoAP), Lightweight Machine-to-Machine Communication; Message Queue Telemetry Transport (MQTT). Introduction to Internet Connectivity Principles, Internet Connectivity, Internet-Based Communication, IP Addressing in the IoT, Media Access Control, 6LowPAN and LoRaWAN. Application Layer Protocols: HTTP, HTTPS, FTP and Telnet.

UNIT 4: **5 lecture hours**

Security and Privacy Requirements, Threat Analysis, IoT Layered Attacker Model, Access Control and Secure Message Communication, Security Models.IoT Hardware (development Boards): Raspberry pi, Arduino, NodeMCU, etc.SDN, NFV, Humanoid, Drones, 5G.

Laboratory:

Network programming hands on guide. Hands-on exercises on IoT hardware and software. Develop IoT Capstone Project.

Text Books:

1. *Raj Kamal, Internet of Things: Architecture and Design Principles (1st ed.), TMH Publications, 2017. ISBN 978-9352605224.*
2. *Vijay Madisetti and Arshdeep Bahga, Internet of Things (A Hands-on-Approach) (1st ed.), VPT, 2015. ISBN 978-0996025515.*

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Name of Program	Bachelor of Computer Applications				
BCAP318	Blockchain Technologies: Platforms & Applications	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: To articulate blockchain platforms that show promise in solving complex business problems.
CO2: To examine the life cycle of a chain code and its components.
CO3: To make use of various blockchain-based enterprise applications

Course Contents:

UNIT 1: **8 lecture hours**
Blockchain platforms: Ethereum, Hyperledger Project, IBM Blockchain, Multichain, Hydrachain, Ripple, R3 Corda, BigChainDB, IPFS, Building Dapps, Ethereum consensus, Proof of Authority, Ethereum Client, Mist Wallet, Accounts.

UNIT 2: **8 lecture hours**
Contract creation code, Deploying solidity code, Web3js and RPC protocols, Miners, Transaction and Block in Ethereum, Front End Development, Fabric Model, Identity management in Fabric, MSP in fabric, Policies, Ledgers in fabric, Chaincode, Multiple chaincodes on fabric, Endorsement peers.

UNIT 3: **7 lecture hours**
Ordering nodes, committing peers, Anchor peers, creating organizations via fabric, Life cycle of chain code, packing transactions into blocks, Validation and commit, Channels, Solo ordering service, Kafka, Sharing private data, Private data sharing patterns.

UNIT 4: **5 lecture hours**
Key level transaction access control, Key level endorsement, Set up a cluster on fabric model, Set up your CA, Use the CA to create local MSPs, Deploy a production network on HF.

Laboratory:
This laboratory course enables students to get practical knowledge on Blockchain platforms like Ethereum, Hyperledger, IBM Blockchain, Multichain, Hydrachain, Ripple, R3 Corda, BigChainDB, Open-chain and IOTA. Further, Students will use these Blockchain platforms to solve real-world problems in various sectors like Financial, Digital identity, Education sector, Logistics, Health sector, Insurance, Retail, Agriculture, and Land registrations.

Text Books:

1. *Serres, Tom, Bill Wagner and Bettina Warburg, Basics of Blockchain (1 ed.), Animal Ventures LLC, 2019. ISBN 9781089919441.*
2. *Larry A. DiMatteo, Michel Cannarsa and Cristina Poncib, The Cambridge Handbook of Smart Contracts, Blockchain Technology and Digital Platforms (1 ed.), Cambridge University Press, 2019. ISBN 978-1108492560.*

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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 Computer Applications				
BCAP319	Smart Contracts and Solidity Programming	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: To articulate smart contracts and construct Decentralized Applications.
CO2: To build solidity programming constructs.
CO3: To implement various smart contracts using solidity.

Course Contents:

UNIT 1: **7 lecture hours**
Why Smart Contracts, structure of a smart contract, solidity constructs, global variables in solidity, Life cycle of a solidity contract, Interfaces, External function calls, fall back functions, Payable functions, Revert, assert, Require, Decentralized Autonomous Organization tokens, Maker DAO.

UNIT 2: **9 lecture hours**
Token based membership, Share based membership, Automated immutable systems, Ethereum with DAOs, Pure functions, View functions, Ethereum Virtual Machine (EVM), Byte Code interpretation, Ethereum mining reward scheme, Gas pricing, Ethereum development.

UNIT 3: **7 lecture hours**
Whisper, Swarm, Raiden Network, State Channels, Development with Solidity, Development environments, MIX (The DApp IDE), Ether.camp, Truffle, Sublime, testRPC, Development and reuse of common patterns, modifiers driven development, contract driven development, testing.

UNIT 4: **5 lecture hours**
Smart contract security issues, Common attacks on smart contract, Error Handling in smart contracts, Modifiers, Mutex Pattern, Balance limit pattern, Smart contract security tools, Smart Inspect, GasTap, Smart Check, Solgraph, advance research topic of Smart Contract.

Laboratory:
This lab enables students to get recognize the architecture and components of Ethereum, Decentralized Applications (DApps). Further, students will learn syntaxes for doing Solidity programming to create and deploy DApps using Ethereum. This laboratory includes tools like Remix, Ganache, MetaMask, Node JS to build and deploy the smart contracts on Blockchain network. Besides, students will get practical knowledge on Web3.js or Ethereum JS API works, Truffle.JS framework to compile Smart Contracts, automate contract testing and Blockchain based web development.

Text Book:
1. *Reed and Jeff, Smart contracts: The essential guide to using blockchain smart contracts for cryptocurrency exchange (1 ed.), CreateSpace Independent Publishing Platform, 2016. ISBN 978-1539457442.*

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 Computer Applications				
BCAP320	Digital Currencies and Blockchain	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: To articulate blockchain-based digital currencies and data structure of the bitcoin digital currency.
CO2: To examine different approaches of digital currencies.
CO3: To implement the different digital currency wallet types and transactions using different types of wallets.

Course Contents:

UNIT 1: **8 lecture hours**
Digital currency, cryptocurrency vs fiat currency, web 3.0, transactions in digital currencies, bitcoin model, Bitcoin Structure, Bitcoin implementation, public and private addresses, alternative cryptocurrencies-ETH, Ripple, Litecoin, Matic, Bitcoin network architecture, Data structure of the bitcoin blockchain, Stack for bitcoin blockchain, Linked list representation of bitcoin blockchain, Operations on the bitcoin blockchain, special variables in Bitcoin.

UNIT 2: **8 lecture hours**
Bitcoin storage, Bitcoin mining, Bitcoin Services and functionality, Bitcoin forks, Users in the Bitcoin system, Applications of Bitcoin, Impact of Bitcoin mining, Bitcoin anonymity, Blockchain verification, Bitcoin consensus, Full nodes vs. SPV (Simplified Payment Verification) nodes, Light nodes.

UNIT 3: **6 lecture hours**
Mining economics, Mining infrastructure, the Bitcoin Script language, reverse polish notation, script writing, script execution, bitcoin wallets, types of wallets, security implications of the different type of wallets, Dark web.

UNIT 4: **6 lecture hours**
Socio-political impact, and regulation on crypto currencies, Law enforcement on Bitcoin, sudden growth of Bitcoin, Bitcoin impact on society, issues with bitcoin, Bitcoin impact on environment, Bitcoin application other than cryptocurrency, Bitcoin vs file coin, startups in Digital Currencies.

Laboratory:
This laboratory course enables students to get practical knowledge on cryptocurrencies and associated wallet creation to transfer of crypto currencies like Bitcoin, Ethers etc. In this course students will learn to use cryptocurrencies to purchase various goods and services using Decentralized Blockchain network. Further, the goal of this laboratory is implementation of "payment," the initiating process of funds transfer using blockchain technology. The funds transfer will be realized with participation of sending and receiving banks' in blockchain environment and by their exchange of transfer messages through the environment. Though "clearing" and "settlement" operations follow payment in actual operations.

Text Book:

1. *Lewis, Antony. The Basics of Bitcoins and Blockchains: An Introduction to Cryptocurrencies and the Technology that Powers Them (Cryptography, Crypto Trading, Digital Assets, NFT) (1 ed.), Mango media, 2018. ISBN 978-1633538009.*

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 Computer Applications				
BCAP321	Blockchain Policy: Legal, Social and Economic Impact	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: To explain cryptocurrencies and law enforcement at the world stage.
CO2: To examine the arguments for Cybersecurity related policy frameworks.
CO3: To implement various decentralized applications using blockchain technology.

Course Contents:

UNIT 1: **8 lecture hours**
Why Blockchain policy, guidelines for Block Chain Applications and Infrastructures, international laws to Block Chain, DLT Dialogue, DLT Policy, preventing money laundering, Terrorism financing, FATF Standards on virtual assets, Stable coins and their policy implications, issues related to trust, Framework, Challenges, business impact, Resources, Smart Securities and Derivatives.

UNIT 2: **8 lecture hours**
Tokenization, Securities to physical assets, impact of Block Chain on different stakeholders, shareholder engagement and investor privacy, Blockchain industry bodies around the world, corporate governance on the chain, Impact on specific communities, Problem of equality and Block Chain, Role of Block Chain in the ecosystem for persons with Disability, Impact of Block Chain on women, Tax administration to transparency, Tax treatment of digital financial assets.

UNIT 3: **6 lecture hours**
Enabling sustainable infrastructure investment, Digital financial marketplaces, Track and Trace, Provenance to countering fraud, Agricultural supply chains and policy makers, Material supply chains, facilitating international trade, Trade finance to customs, how government can support Blockchain innovation, Blockchain adoption.

UNIT 4: **6 lecture hours**
Blockchain and the environment, technical assistance with Blockchain, Steering Blockchain through the energy transition, Blockchain reduce the cost of remittances, potential unintended consequences, criminal activities, inequality, privacy security and data protection, IP regulations.

Laboratory:
This laboratory course enables students to get practical knowledge on how law enforcement catches cryptocurrency criminals. Cybercriminals use blockchain-based cryptocurrencies such as Bitcoin for various purposes like laundering dirty money, scamming victims out of funds, defrauding investors, monetizing ransomware, or buying illicit goods. In this course, students will learn about the creation of new cryptocurrencies by using soft and hard fork mechanisms. Further, designing and developing the decentralized application for a marketplace where sellers can add items with the cost of some crypto tokens

and consumers will use blockchain-based cryptocurrencies to purchase the goods using their wallet addresses with the law of enforcement.

Text Book:

1. *Hacker, Philipp and Ioannis Lianos. Regulating Blockchain: Techno-Social and Legal Challenges (1 ed.), OUP Oxford, 2019. ISBN 978-198842187.*

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 Computer Applications				
BCAP322	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)

By the end of this program, students should have the following knowledge, skills, and values:

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: **8 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: **8 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: **6 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: **6 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.

Laboratory:
Cyber-Security with Blockchain is to make companies, products, systems, and services as resilient as possible to cyber-attacks, by looking at security from the outset and throughout their entire life cycle. This lab enables students to get practical knowledge on cryptographic primitives, design, and analysis of authentication protocols. Further, this lab mainly focusses on Transaction and communication security, preventing DDOS attacks, preventing data manipulation, and protection from compromised nodes.

Text Book:
1. *Gupta, Rajneesh. Hands-on cybersecurity with blockchain (1 ed.), Packt Publishing, 2018. ISBN 978-788990189.*

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 Computer Applications				
BCAP323	Modern Cryptography	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

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: **8 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: **9 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: **11 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.

Laboratory:

Insert malicious shell code into a program file and check its malicious or benign status, create Client Server program to send data across systems as two variants clear text data and encrypted data with different set of encryption algorithms, demonstrate Buffer Overflow and showcase EIP and other register status, perform ARP poisoning, SQL Injection and demonstrate its countermeasure methods, implement stateful firewall using IP Tables, showcase different set of security protocol implementation of Wireless LAN.

Text Book:

1. *Stallings, William. Network Security Essentials (4th ed.), Prentice Hall, 2018. ISBN 978-9352866601.*

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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 Computer Applications				
BCAP324	Special Topics in Blockchain	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

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 Blockchain.

Course Contents:

UNIT 1: **28 lecture hours**

This course covers the cutting-edge topics in Blockchain, and these modules will be chosen by the instructor based on the requirements and relevance at that point of time. These modules 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 modules.

Laboratory:

Students will gain practical experience by using tools and technologies related to Blockchain.

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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 Computer Applications				
BCAP325	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)

By the end of this program, students should have the following knowledge, skills, and values:

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: **10 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 Stackdriver 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: **10 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: **8 lecture hours**

Deploying and implementing data solutions, Cloud SQL, Cloud Datastore, BigQuery, Cloud Spanner, Cloud Pub/Sub, Cloud Bigtable, Cloud Dataproc, Cloud Dataflow, Cloud Storage, Loading data, Deploying and implementing networking resource, Monitoring and logging, Creating Stackdriver alerts based on resource metrics, Creating Stackdriver custom metrics, configuring log sinks to export logs to external systems, Viewing and filtering logs in Stackdriver, Viewing specific log message details in Stackdriver, 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:

1. *Rajan, Legorie, Steven Porter, and Ted Hunter, Building Google Cloud Platform Solutions (1st ed.), Packt Publishing, 2019. ISBN 97818386474382.*

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 Computer Applications				
BCAP326	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)

By the end of this program, students should have the following knowledge, skills, and values:

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: **7 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: **6 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: **8 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: **7 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.

Laboratory:
In-studio works, the student will be able to practically understand how all the security attacks does have happened on mobile devices, as well as learn to recognize and remove common coding errors that lead to vulnerabilities. This lab also gives an outline of the techniques for developing a secure application code by analyzing malware for mobile devices. Setup your kali lab, Install Android Emulator, ADB and Database Isolation, Build your own malware app and steal other app files, Recovering protected secrets and Application patching, Acquire malicious apps, Perform static malware analysis, Perform malware injection, Invoking Internal Activities Using Malicious Intents and – attacking broadcast receivers, Parameter Manipulation Using a Proxy, Bypassing SSL Pinning, Memory dumps and objects analysis, Bypass Application Restrictions without Modifying Any Code, Identifying code level vulnerabilities: security code review.

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))

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.*

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 Computer Applications				
BCAP327	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)

By the end of this program, students should have the following knowledge, skills, and values:

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: **6 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: **8 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: **14 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.

Laboratory:
Consists of using network monitoring tools, implementing different types of attacks and some protection schemes of various IoT devices.

Text Books:

1. *Saravanan, Vijayalakshmi. Securing IoT and Big Data: Next Generation Intelligence (Internet of Everything (IoE) (1st ed.), CRC Press, 2020. ISBN 0367432889.*
2. *Chandra,.Rajasekharaiah. Cloud-Based Microservices: Techniques, Challenges, and Solutions (1st ed.), Apress, 2020. ISBN 9781484265642.*

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 Computer Applications				
BCAP328	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)

By the end of this program, students should have the following knowledge, skills, and values:

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: **6 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: **18 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: **7 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: **7 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.

Laboratory:

In-studio works, the student will be able to practically understand Signal Disruption Attacks , Medium Access Layer Vulnerabilities, Network Layer Protocol Vulnerabilities, Countermeasures for Each Attack in Network Layer Protocol: RIP, OSPF, Network Layer Protocol Vulnerabilities, Countermeasures for Each Attack in Network Layer Protocol: BGP, Transport Layer Protocol Vulnerabilities: UDP, Transport Layer Protocol Vulnerabilities : TCP, Session Layer Protocol Vulnerabilities, Presentation Layer Protocol Vulnerabilities, Application Layer Protocol Vulnerabilities : DHCP, Application Layer Protocol Vulnerabilities :HTTP AND HTTPS DOM- based vulnerabilities, Wireless Access Point Firmware Vulnerabilities.

Text Book:

1. *Sanders, Chris. Practical packet analysis: Using Wireshark to solve real-world network problems (3rd ed.), No Starch Press, 2017. ISBN 978-1593278020.*

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 Computer Applications				
BCAP329	Penetration Testing, Auditing and Ethical Hacking	L	T	P	C
Owning School/Department	Computer Science and Engineering				
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

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: **8 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: **13 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: **7 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.

Laboratory:

Penetration testing using various tools. Crafting malicious packets for network devices like servers, routers, or switches. Crafting malicious software for system vulnerabilities. Ethical hacking on Wired and Wireless Networks.

Text Books:

1. *Harper, Allen. Gray Hat Hacking: The Ethical Hacker's Handbook (6th ed.), McGraw-Hill Osborne Media, 2022. ISBN 1264268947.*

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 Computer Applications				
BCAP330	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)

By the end of this program, students should have the following knowledge, skills, and values:

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: **8 lecture hours**

Exploring the intersection of cyberspace and criminal behavior, examining traditional challenges linked to computer crime, and addressing the rise of e-Cash as a novel predicament for law enforcement. Investigating issues such as hacking and the complexities surrounding 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: **7 lecture hours**

Computer Fraud and Abuse Act of 1986, reflecting on the National Information Infrastructure Protection Act of 1996 (NIIPA), tracking the progression of Child Pornography Statutes, and scrutinizing 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: **7 lecture hours**

Common Challenges in Computer Investigations, Forensic Replication, Admissibility of Forensic Duplicates as Evidence, Tool Requirements for Forensic Duplication, Generating a Forensic Duplicate or Qualified Forensic Duplicate of a Hard Drive, Post-Incident Detection Phase. 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: **6 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, Trademark Dispute Jurisdiction, Copyright in the Digital Realm, Copyright and WIPO Treaties, Understanding Patent Rights (30), Laws Regarding Cryptography, Ethical Considerations in Cybercrime.

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, T Marjie. Computer Forensics and Cyber Crime: An Introduction (4th ed.), Pearson Education India, 2022. ISBN 9780134847528.*
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.*

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 Computer Applications				
BCAP331	Web Security	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

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: **5 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: **7 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 defence, Cross-Site Request Forgery, Advanced CSRF defence, Clickjacking, HTML5 Securities, other security problems.

UNIT 3: **8 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: **8 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.

Laboratory:

In this Lab, the student will be able to practically understand HTTP Host header attacks, and its countermeasure: Basic password reset poisoning, Password reset poisoning via dangling markup, Constructing a web cache poisoning attack and its countermeasure Cross-site scripting attacks and its

prevention, XML external entity (XXE) injection, Cross-site request forgery (CSRF), Server-side template injection, Insecure deserialization, Clickjacking, OS command injection, Business logic vulnerabilities: Excessive trust in client-side controls, High-level logic vulnerability, and Low-level logic flaw, Weak isolation on dual-use endpoint and Authentication bypass via flawed state machine.

Text Books:

1. *Hoffman, Andrew. Web Application Security: Exploitation and Countermeasures for Modern Web Applications (1st ed.), O'Reilly Media, 2020. ISBN 978-1492053118.*
2. *Chandra, Rajasekharaiah. Cloud-Based Microservices: Techniques, Challenges, and Solutions (1st ed.), Apress, 2020. ISBN 9781484265642.*

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 Computer Applications**				
BCAP332	**Special Topics in Information Security**	L	T	P	C
Owning School/Department	**Computer Science and Engineering**	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

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 Information Security (IS).

Course Contents:

UNIT 1: **28 lecture hours**

This course covers the cutting-edge topics in Information Security and these modules will be chosen by the instructor based on the requirements and relevance at that point of time. These modules 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 modules.

Laboratory:

Students will gain practical experience by using tools and technologies related to IS.

Text Books:

1. *Stallings, William. Cryptography and network security, 4/E. Pearson Education India, 2006.*
2. *Stallings, William. Network security essentials: Applications and standards, 4/e. Pearson Education India, 2003.*

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 Computer Applications				
BCAP333	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)

By the end of this program, students should have the following knowledge, skills, and values:

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: **6 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: **7 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 lecture 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: **5 lecture 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.

Laboratory:

Organizations that have adopted agile software development are seeing much higher quantities of releases. With the increasing popularity of agile development, a new approach to software releases known as Continuous delivery is starting to influence how software transitions from development to a release. One goal of Continuous Delivery and DevOps is to release more reliable applications faster and more frequently. The movement of the application from a build through different environments to production as a release is part of the Continuous Delivery pipeline. The lab work for this subject deal with the concept that how the students can build and release their software.

Text Books:

1. *Blokdyk, Gerardus. Change and Release, Management A Complete Guide (1st ed.), 5STARCooks, 2021.*
2. *Chandra, Rajasekharaiah. Cloud-Based Microservices: Techniques, Challenges, and Solutions (1st ed.), Apress, 2020. ISBN 9781484265642.*

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 Computer Applications				
BCAP334	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)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: To articulate continuous integration and continuous deployment pipeline, and an automated deployment pipeline.
CO2: To examine the continuous integration tools, jobs, and performance of integration testing.
CO3: To implement the continuous integration and continuous deployment.

Course Contents:

UNIT 1: **7 lecture hours**
Continuous Integration and Continuous Deployment, CI Pipeline, CD Pipeline, CICD Components, CICD roles, CICD Cloud, Continuous Integration on SVC, CI Build Cycle, Architecture.

UNIT 2: **6 lecture hours**
Automated Integration, Automated Vs Manual CI, Installation and Configuration of CI Tool (jenkins), Creating Jobs, Running the Jobs, Build Deployments, CI Documentation principles, Documentation of Tool discussed, CD Build Cycle, CD Architecture.

UNIT 3: **10 lecture hours**
Automated Delivery, Automated Vs Manual CD, Continuous Deployment, Continuous Deployment Requirement, Continuous Deployment Components, Continuous Deployment Build Cycle, Continuous Deployment Architecture, Automated Continuous deployment, Automated Vs Manual Continuous Deployment, Continuous Integration Vs Continuous Delivery Vs Continuous Deployment, Industry Perspective of CICD, Bit Bucket in CICD, Business models of CICD.

UNIT 4: **5 lecture hours**
CICD Pipeline security, Issues, and challenges in security, CICD in Agile Software Engineering, CICD for microservices, Advanced CICD Overview.

Laboratory:
The lab work demonstrates various programming methodologies like extreme programming, pair programming and test-driven development for designing, testing, and refactoring and illustrates automation testing and continuous integration with different tools.

Text Books:

1. *Rossel, Sander. Continuous Integration, Delivery, and Deployment(1st ed.), Packt Publishing Ltd, 2020. ISBN 978-1787284180.*
2. *Hornbeek, Marc. Engineering DevOps: From Chaos to Continuous Improvement... and Beyond (1st ed.), BookBaby, 2019. ISBN 978-1543989618.*

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 Computer Applications**				
BCAP335	**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)

By the end of this program, students should have the following knowledge, skills, and values:

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: **8 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: **8 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: **7 lecture hours**
Testing and Validation, Different Types of Testing, Properties of Testing, Customizable, Extendable, Link Validity, Component Checking, Semantic, and Syntax Parsing.

UNIT 4: **8 lecture hours**
Frameworks, Tools, and the Programming Process, DevOps Frame Definition, Agile Framework, Scaled Agile Framework, Adoption Framework, Industry Practices.

Laboratory:
The lab work of this subject deals with documentation as well as designing projects using different models. The projects should also go through different testing and validation. Also, define appropriate boundaries and layers, and organize components and services.

Text Books:

1. *Fowler, Martin. Refactoring: Improving the Design of Existing Code(2nd ed.), Addison-Wesley, 2019. ISBN 978-0134757599.*
2. *Martin, C Robert. Series, 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 Computer Applications				
BCAP336	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)

By the end of this program, students should have the following knowledge, skills, and values:

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: **5 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: **7 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: **9 lecture 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 4: **8 lecture 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.

Laboratory:

The lab work of this subject deals with Design, development, and solving real-world automation and orchestration problems by unlocking the automation capabilities of Configuration tools (Puppet, Chef, Ansible, and Saltstack) used for DevOps. A small web application-based software is to be developed using any of the tools of DevOps.

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.*

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 Computer Applications				
BCAP337	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)

By the end of this program, students should have the following knowledge, skills, and values:

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: **8 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: **6 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: **7 lecture 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: **7 lecture 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.

Laboratory:
The lab component of this course demonstrates test cases design and illustrates automation testing and continuous integration with tools like Agile and Jenkins. The practical work will help to identify all the stages of your release along with the gates and requirements necessary in a build's journey to production. Also, all the operational procedures, services, and actions involved with a release cycle will be elaborated. 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.).

Text Book:

1. *Platz, Wolfgang and Cynthia Dunlop, Enterprise Continuous Testing: Transforming Testing for Agile and DevOps (1st ed.) CreateSpace Independent Publishing Platform, 2019. ISBN 978-1699022948.*

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 Computer Applications				
BCAP338	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)

By the end of this program, students should have the following knowledge, skills, and values:

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: **8 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: **9 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: **7 lecture 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: **4 lecture hours**
Git Basics and Remote Repositories, BitBucket Server and its working, Security over BitBucket, Creation of Projects over BitBucket.

Laboratory:
The lab components of this course demonstrate how to implement GitHub on desktop to manage local and remote repository and explores the functionality of Software Version Control Systems with hands-on experience of concepts taught in the lecture.

Text Books:

1. *Blokdyk, Gerardus. Distributed Version Control System A Complete Guide (1st ed.), 5STARCooks, 2021. ISBN 978-1867331193.*
2. *Leornardo, M 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 Computer Applications				
BCAP339	Special Topics in DevOps	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

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 DevOps.

Course Contents:

UNIT 1: **28 lecture hours**

This course covers the cutting-edge topics in DevOps, and these modules will be chosen by the instructor based on the requirements and relevance at that point of time. These modules 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 modules.

Laboratory:

Students will gain practical experience by using tools and technologies related to 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 Computer Applications				
BCAP340	Auto Pilot and Flight Control	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: To understand Autopilot and autonomous mission design.
CO2: To construct autonomous UAV missions using programming Autopilot hardware.

Course Contents:

UNIT 1: **6 lecture hours**
Auto Pilot; Flight Control: Linear Flight Control, Non-Linear Flight Control, Adaptive Flight Control; Open-Pilot; Pixhawk; Paparazzi; ArduPilot; DroneKit- Python.

UNIT 2: **7 lecture hours**
MAVLink: Message Format, High-Level Message Flow; Auto-Pilot Data Channelling; MAVLink Routing; CAN Bus; UAVCAN Protocol; ROS: Robot Operating System; MAVROS; MAVProxy.

UNIT 3: **8 lecture hours**
Mission Planner Firmware; Waypoints and Events; Camera Control; Mission Planning Setup; Mission Planning Calibration; Flight Setup; Autonomous Missions; Vehicle Calibration; Vehicle Attitude; Vehicle Positioning.

UNIT 4: **7 lecture hours**
Terrain Recognition; Mapping; Surveillance; Video and Image Tracking; Failsafe; Vehicle Health.

Laboratory:
In-studio work, students will start with ArduPilot and Pixhawk flight controllers, components, and learn to create autonomous UAV missions using programming MAVLink and UAVCAN protocols.

Text Book:
1. *Alberto, Julio. Mendoza-Mendoza, Victor Javier Gonzalez-Villela, Gabriel Sepulveda- Cervantes, Mauricio Mendez-Martinez and Humberto Sossa-Azuela. Advanced Robotic Vehicles Programming: An Ardupilot and Pixhawk Approach (1st ed.), Apress, 2020. ISBN 1484267184.*

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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 Computer Applications				
BCAP341	Drone Communication	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: To understand components, attributes, and challenges associated with the developing field of aerial communications.
CO2: To configure aerial vehicles using MAVLink and UAVCAN

Course Contents:

UNIT 1: **7 lecture hours**
UAV Miniaturization: Challenges and Opportunities; Unique Network Characteristics; Aerial Mobility Models; Aerial Communication: Radar Identification, Beyond Radar Measurements, Aerial Voice Communication; Single Antenna Systems; Multi-Antenna Systems; Communication Design Requirements: Vehicular Environment, 3D Tracking, Spontaneous Mobility, Timing Constraints, Device Autonomy, Mission Autonomy.

UNIT 2: **9 lecture hours**
Data Link Functions; Data Link Attributes; Data Link Margin; AJ Margin; Propagation; Data Rate; Data Link Trade Off; Aerial Channel Modelling: Free Space Path Loss, Ray Tracing, Long Distance Path Loss, Shadowing, Line of Sight Probability, Atmospheric Interventions; MAVLink Protocol; MAVLink Message Types; MAVLink; Message Format; MAVLink Heartbeat; MAVLink Commands; MAVLink Security Requirements; MAVLink Security Threats.

UNIT 3: **8 lecture hours**
UAV for Coverage; UAV for Data Collection; UAV Assisted Wireless/Cellular Networks; Cooperative Communication; UAV Assisted Ground Networks; Disruption-Tolerant Airborne Networks; UAV Security; UAV Safety; Drone Communication: Smart Cities; Under Water; UAS Safety Deployments; Security in Smart Cities; Internet of Drones.

UNIT 4: **4 lecture hours**
Mobile Technology EnabledDrones; LTE; Integrating UAS into the NAS: Civil Aviation, Legislation; 3GPP Standardization on UAV.

Laboratory:
In lab works, students will configure and deploy UAVs using MAVLink and UAVCAN protocols.

Text Book:
1. *Saad, Walid. Mehdi Bennis, Mohammad Mozaffari and Xingqin Lin, Wireless Communications and Networking for Unmanned Aerial Vehicles (1st ed.), Cambridge University Press, 2020. ISBN 1108480748.*

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 Computer Applications				
BCAP342	UAV Mission Planning and Deployments	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: To understand various parameters and environmental considerations for efficient deployment of Unmanned Aerial Systems.
CO2: To perform site survey and operational characteristic analysis and develop mission deployment accordingly.

Course Contents:

UNIT 1: **9 lecture hours**
Mission Planning and Control Station; Physical Configuration; Planning; Navigation; Target Location; Air Vehicle; Payload Control; Remote Pilot; Assisted Auto Pilot; Complete Auto-Pilot; Payload; Reconnaissance/Surveillance Payloads; Target Detection; Recognition; Identification; Searching Stable Line of Sight.

UNIT 2: **7 lecture hours**
Weapon Payloads; Capacity; Structure; Interference; Radar; Chemical, Nuclear and Meteorological Sensors; Fixed Wing UAV Launch Systems; Vertical Take-off and Landing; Conventional Landing; Vertical Net Systems; Parachute Recovery; VTOL UAVs; Mid Air Retrieval; UAV Launch Method Trade-offs; UAV Recovery Trade-offs.

UNIT 3: **7 lecture hours**
Aerial Photography; Photogrammetry; Radiometric Errors and Effects; Radiometric Correction; Geometric Errors and Effects; Georeferencing and Geometric Correction; Georeferenced Point Clouds; Digital Elevation Models; Image Enhancement; Image Classification; UAS Imagery Mission Planning; Product Specification; Accuracy Requirements; Operational Site Restrictions.

UNIT 4: **5 lecture hours**
Digital Sensors; Geometry of Vertical Imagery; Aerial Imagery Collection; Flight Plan and Layout Design; Aerial Cinematography; Camera Angle; Navigation; Narration; Platform Accessories; Cinematography Technique.

Laboratory:
In project work, students will be developing independent surveillance missions based on underlying geography and geometry.

Text Book:
1. *Barnhart,R. Kur,t Douglas M. Marshall and Eric Shappee, Introduction to Unmanned Aircraft Systems (1st ed.), CRC Press, 2021. ISBN 9780367366599.*

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 Computer Applications				
BCAP343	UAV Simulation	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: To understand modeling platforms and 3D simulations of real-time UAS mission objectives.
CO2: To model UAV missions using emulators and gaming engines.

Course Contents:

UNIT 1: **9 lecture hours**
Experimental Process; Software Platform Configuration; Hardware Configuration; Simulink Based Control Design; UAV Scenarios; UAV Bindings; UAV Platform; Fixed Wing; Quadcopter; Attitude; Representation; Coordinate Frame; UAV Waypoints; External Attitude Control in Copter; External Attitude Control in Fixed Wing UAVs.

UNIT 2: **6 lecture hours**
Sensor Calibration; Sensor Data Aggregation; State Estimation and Filter Design; Complementary Filter; Kalman Filter; Extended Kalman Filter; Trajectory Generation; Axis Angels; Euler Angels; Quaternions; Rotation Matrices; Point Clouds.

UNIT 3: **6 lecture hours**
Waypoint Following; Waypoint Trajectories; Tuning Waypoints; UAV Path Management; UAV Obstacle Avoidance; Moving Obstacle Avoidance; High Fidelity UAV Guidance Model; Transition from Low to High Fidelity Models.

UNIT 4: **7 lecture hours**
Motion Planning using RTT; Motion Planning using Light Detection and Ranging; MAVLink; MAVLink Parameter Protocol; MAVLink Data Exchange; Flight Log Analysis.

Laboratory:
In the studio work, students will learn to model Pixhawk and ArduPilot systems using MATLAB and Unreal engines.

Text Book:
1. *Quan, Xunhua Dai and Shuai Wang, Multicopter Design and Control Practice: A Series Experiments based on MATLAB and Pixhawk (1st ed.), Springer Singapore, 2020. ISBN 9811531374.*

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 Computer Applications				
BCAP344	Drone Swarming	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: To understand, model, implement and configure naturally occurring swarming behaviors to the hardwired aerial robots.
CO2: To Construct a fleet of autonomous aerial vehicles that work together to achieve a common goal.

Course Contents:

UNIT 1: **8 lecture hours**
Introduction to UAV Swarms; Swarm Performance; Self-Organization and Feedback; Self-Organizing Systems; Emergence; Homogeneous Swarms; Heterogeneous Swarms; Cognitive Mapping; Aggregation; Clustering; Dispersion; Self-Assembly; Collective Construction; Collective Transport; Collective Manipulation; Flocking; Collective Motion; Foraging.

UNIT 2: **9 lecture hours**
Modelling Swarm Systems; Decision Making; Collective Decision Making; Collective Motion as Decision Making; Collective Decision-Making Models; UAV Networking Architecture; UAV Communication Topology; UAV Networking Scenarios; Object Detection and Tracking using Deep Learning; Obstacle Avoidance using Deep Learning; Autonomous Landing using Deep Reinforcement Learning; Autonomous Landing using Fast Reinforcement Learning; UAV Formation Architecture; UAV Formation Control Models; Consensus-Based Formation Control Models.

UNIT 3: **5 lecture hours**
UAV Mobility: Spatiotemporal Predictions; Multivariate Spatiotemporal Predictions; Deep Spatiotemporal Residual Networks; UAV Mobility Models for Reconnaissance Swarms; Search and Rescue; Independent Mobility Models.

UNIT 4: **6 lecture hours**
UAV Routing Topologies; Computation Applications; Directional Airborne Networks; Low Probability Detection; Security Threats; Security Requirements; Jamming Characteristics; Security Protocols; Resilient UAV Networks.

Laboratory:
In project work, students are required to develop a UAV mission that replicates biologically occurring swarms to achieve predefined objectives using custom programmed flight controllers.

Text Book:
1. *Bouffanais, Roland. Design and Control of Swarm Dynamics(1st ed.), Springer, 2016. ISBN 9812877509.*

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 Computer Applications				
BCAP345	Drone Applications, Components and Assembly	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: To understand UAVs, UAV application, needs, deployments, and advancements.
CO2: To construct multirotor UAVs from scratch using various flight controllers.

Course Contents:

UNIT 1: **6 lecture hours**
Technological Advancements; Unmanned Aerial Vehicles; Unmanned Aerial Systems; UAV Concept of Operations (CONOPs); UAV Chemical, Biological, Radiological and Nuclear (CBRN); UAV Classification: Wing Geometry Based, Payload Based, Size Based, Mission-Based, UAV Anatomy, Mission Planning.

UNIT 2: **8 lecture hours**
Wing Configuration and Thrust; Airframe Configuration; Aerodynamic Configuration; Vibration and Noise; UAV Propulsion; Propeller Modelling; Motor Modelling; UAV Communication; Radio Wave Communication; Microwave Communication; Line of Sight Communication; Beyond Line-of-Sight Communication; Waypoint Tracking Navigation.

UNIT 3: **7 lecture hours**
Sensor Calibration; Tracking using GPS; UAV Stability; UAV Controllability; Flight Control; Autonomous Control; Semi-Autonomous Control.

UNIT 4: **7 lecture hours**
Drone Sensing and Imagery: Riverine, Aquatic, Agriculture, Vegetation and Forest Ecosystem, Oil and Gas, Surveillance, Search and Rescue; UAS Ground Control; Human Machine Interface; Computer Telemetry; UAV Launch System; UAV Recovery System.

Laboratory:
In Lab work, students will start with basic Multicopter design principles, components, and assembly precautions. Then finally design and develop a fully functional Multicopter UAV/Drone using off-the-shelf Flight Controllers.

Text Book:
1. *Quan, Quan. Introduction to Multicopter Design and Control (1st ed.), Springer, 2017. ISBN 9789811033810.*

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 Computer Applications				
BCAP346	Special Topics in Drone Technology	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

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 Drone Technology.

Course Contents:

UNIT 1: **28 lecture hours**

This course covers the cutting-edge topics in Drone Technology, and these modules will be chosen by the instructor based on the requirements and relevance at that point of time. These modules 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 modules.

Laboratory:

Students will gain practical experience by using tools and technologies related to Drone Technology.

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 Computer Applications				
BCAP347	Server-Side Development Frameworks: Express and Spring	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: To articulate the Express which is a minimal and flexible Node.js web application framework that provides a robust set of features for web and mobile applications.
CO2: To examine server-side development of web applications using Spring framework using Java language.
CO3: To make use of the interaction with backend databases such as mongo dB, MySQL, PostgreSQL with Express and Spring applications.

Course Contents:

UNIT 1: **7 lecture hours**
Introduction to Full Stack Development, Server-side Development: Node, Node modules and the Node HTTP server, Third party modules: mongoose, angular, react, express, npx, npm, brew, http server usage and options, Express framework, REST (REpresentation State Transfer (REST)) API server with Express, Get, post, put, delete, Node server with Express, Postman for API Testing Automation, Mongo dB database.

UNIT 2: **7 lecture hours**
Interacting with MongoDB from a Node application, Install mongo dB using npm, Import mongo client, Connect to client, Query execution from script file (node sample.js), Mongo and Mongoose, authentication and session-based authentication, Npm express-session, Token-based authentication with the support of JSON web tokens and the Passport module, Modules: express, passport, jsonwebtoken, Fundamental concepts of Spring Core: Dependency Injection (DI) and Inversion of Control (IoC), Automated Java-Based Configuration: @Component, @Autowired, @ComponentScan, Constructor Injection, Field Injection, Setter Injection.

UNIT 3: **6 lecture hours**
Spring Core application with Maven, Using Eclipse, Contents of pom.xml, Spring Framework support for Model, Controller and View pattern Directory Structure of Spring MVC using Maven, Required Jar files or Maven Dependency, Entry of controller in the web.xml file, Define the bean in the xml file, Displaying the message in the JSP page, Java, Spring MVC, Spring Security, Algorithm, Hibernate, Maven, Mysql Integration Application, Java Persistence API (management of relational data in the Java applications) and Hibernate (Object-Relational Mapping (ORM)), JPA (javax.persistence), Hibernate (org.hibernate), JPA (EntityManagerFactory), Hibernate (SessionFactory), JPA (Java Persistence Query Language (JPQL)), Hibernate (Hibernate Query Language (HQL)).

UNIT 4: **8 lecture hours**
CRUD paradigm in java application, RESTful web service: Create (POST), Read (GET), Update (Put), Delete (DELETE), Basic PostgreSQL data storage and management capabilities [create a database, drop a

database, select database, select table, update a record, create a table, delete record, drop table, triggers, functions, insert the record, procedures, cursors], Spring SecurityBasics, Spring Security Features, Spring Security Authentication, Spring JDBCTemplate Introduction, RowMapper, Builder, Spring Boot, JDBCTemplate using Postman API Hands on Session.

Laboratory:

Studio work consists of server-side development using Express framework based on node.js, use REST API with Express to interact with backend server. To develop Java Spring web applications using MVC. Also learn to integrate both frameworks with databases such as mongo dB, MySQL and PostgreSQL.

Text Book:

1. *Greg Lim, Beginning Node.js, Express & MongoDB Development (1st ed.), Paperback, 2020. ISBN 9789811480281.*

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 Computer Applications				
BCAP348	VR Gaming	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

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: **10 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: **9 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: **9 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.

Laboratory:

This lab enables students and staff to visualize designs, develop immersive VR environments, and to test new VR technologies. The lab features threedimensional (3D) projections on the walls and floor, as well as sensory feedback, so participants can manipulate objects like medical tools.

Text Book:

1. *Jesse Glover and Jonathan Linowes, Complete Virtual Reality and Augmented Reality Development with Unity: Leverage the power of Unity and become a pro at creating mixedreality applications (1st ed.), Packt Publishing Limited, 2019. ISBN 1838648186.*

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 Computer Applications				
BCAP349	Augmented Reality	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

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: **11 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: **11 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: **6 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.

Laboratory:

The laboratory of Augmented reality is designed to provide a practical exposure to the students about the concepts and topics taught in the classroom sessions. Case Studies: - Face-to-Face Collaboration – Shared Space - Remote Collaboration – AR Conferencing, Wearable AR Conferencing - Seamless Collaboration – The Magic Book.

Text Books:

1. *Alan B Craig, William R Sherman and Jeffrey D Will, Developing Virtual Reality Applications: Foundations of Effective Design (1st 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) (2nd ed.), Pearson Education, USA, 2017. ISBN 978-0134034324.*

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 Computer Applications				
BCAP350	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)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: To articulate different types of bodies and their dynamics, used in game programming.
CO2: Implement the collision detection and their resolution techniques.

Course Contents:

UNIT 1: **11 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.

UNIT 2: **10 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 3: **7 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.

Laboratory:

To implement basic and advanced concepts using a 3D physics engine like bullet or Open Dynamics Engine (ODE). The objective is to design an active physics controller for a virtual creature.

Text Book:

1. *David M Bourg and Bryan Bywalec, Physics for Game Developers (2nd ed.), O'Reilly Media, 2013. ISBN 978-1449361037.*

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 Computer Applications				
BCAP351	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)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: To explain the fundamentals of Game Programming in HTML5 and understanding the elements of programming in 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: **8 lecture hours**

HTML5 Multimedia, Game framework, FrameRate 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: **11 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, RepaintCollector, LoopGoverner, Animated component, Animation library, ComponentPainter, ComponentUpdater, ComponentAnimator. Advanced Graphics, HardwareAccelerated 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, GridCartographer and GradientCartographer.

UNIT 3: **9 lecture hours**

HTTP Tunneling, Reusable Client and server-side code, Game specific client and server side code, HTTP Polling, HTTP Pulling, HTML5 file upload anddownload, File API and Ajax / XHR2, Drag and drop files, IndexedDB, HTML5 Multimedia, Web Components, Web Workers, The Orientation and Device Motion APIs.

Laboratory:

This course lab is about building a complete multiplayer game server using Node.js and WebSockets, Planning and choosing tools for mobile game development with HTML5, Optimizing game performance with offline cache, minification, and other techniques.

Text Book:

1. *Aditya Ravi Shankar, Pro HTML5 Games, Learn to Build Your Own Games Using HTML5 and JavaScript (1st ed.), Apress, 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 Computer Applications				
BCAP352	AI for Games	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

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: **11 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: **10 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: **7 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.

Laboratory:

This course labs aim to use the power of AI in Gaming design and development using modern Game and AI resources

Text Book:

1. David Bourg and Glenn Seemann, AI for Game Developers: Creating Intelligent Behaviour in Games (1st ed.), O'Reilly Media, 2020. ISBN 978-0596005559.

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 Computer Applications				
BCAP353	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)

By the end of this program, students should have the following knowledge, skills, and values:

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: **6 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: **8 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: **8 lecture hours**
Rendering, rendering techniques, Photorealistic rendering, Shading, VRaySun, VRay Light, Ray Tracing, Creating Animations: particles and dynamics, rendering the animation, automating the output of multiple still images, rendering a shadow study, creating a walkthrough, output options, particle systems: creating hierarchies.

UNIT 4: **6 lecture hours**
Animating modifiers, animating elements, animation helpers, using dummy objects, dynamics and reaction, Dynamic Objects: damper, Spring, simulation mass FX.

Laboratory:
The experiments to create an image of an object with the different lighting condition. Light the scene with direct and indirect light, Rendering out Animation. Creation of a short-animated movie.

Text Book:
1. *Alan H. Watt and Mark Watt, Advanced Animation and Rendering Techniques Theory and Practice (1 ed.), ACM Press, 1992. ISBN 9780201544121, 0201544121.*

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 Computer Applications				
BCAP354	Pixel and Poly Arts for Games	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: To explain the tools and knowledge required for creating simple art for video games made in a game engine.
CO2: To implement whole pipeline from creation to setting up in a game engine.

Course Contents:

UNIT 1: **8 lecture hours**

Introduction to pixel art, Pixel art environment, Environment Design, Pixel art characters, Pixel art character design, Pixel Art Animation, Animation in Photoshop, Animating an Idle Animation, Animating a Run Cycle, Low Poly Game Art, Objects and Tools, Modeling Tools, Sub-Division Modeling, Rigging and Animation, One point vs two-point perspective, Modeling, Understanding UVs and Mapping, Texturing.

UNIT 2: **10 lecture hours**

Low Poly Environment Art, Rock designing, Island, wall, and gate designing. Low Poly Character Art, Body modeling (head, torso, legs, arms, and hands), Model .costume, Model cleanup, Unwrapping, UV layout, Animating Low Poly Art, Skeleton, Skinning, Walk Cycle, Idle Animation, 3D Game Prop Production, Essentials Normals and Baking, Essential Modeling Tips and tools, Essentials Substance Painter and ZBrush, Initial Block-In.

UNIT 3: **10 lecture hours**

Mid-Poly Block-In Model, Mid-Poly Objective Lens, Mid-Poly Eye Piece Swivel, Mid-Poly Eye-Piece Viewer, Mid-Poly Body, Mid-Poly Swivel and Strap Mount, High-Poly Objective Lens, High-Poly Eye Piece Swivel, High-Poly Eye-Piece Viewer, High-Poly Body, High-Poly Floaters, PBR Texturing, Baking Texture Maps, Creating Initial Textures in Substance Painter, Adding Height-Map Details, Creating and using Texture Stencil, Texturing Surface Noise, Dirt, & Wear, Rendering in Marmoset, Compositional Studies for Concept Art, Introduction to 3D for Concept Art (The Drawing, Modifying, and Offset Tools), Setting Up the Layers, Lighting the Foreground, Managing the background and object, Finishing.

Laboratory:

In this course lab students will create pixel art assets for games, create low-poly 3D assets for games, understand how to study composition, create environment concept painting, create a current gen photo-realistic game prop.

Text Book:

1. *Jesse Schell, The Art of Game Design, A Book of Lenses (2nd ed.), Taylor & Francis, 2015. ISBN 9781466598645, 1466598646.*

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 Computer Applications				
BCAP355	Game Design, Development and Programming	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

CO1: To articulate the workflow for creating video games and usage of subcomponents of game engines such as graphics, physics and audio engines.
CO2: To develop realistic scenes and environments. Design, write and deploy 2D and 3D games.

Course Contents:

UNIT 1: **10 lecture hours**
Game design, Aspects of game design, Components in a game, Game engines, Geometric primitives, 2D and 3D linear transformation, Game state, Interactive Storytelling, Game mechanics, Rules and Discovery, Game engine essentials, Interface and Assets, Game engine Interfaces, Prototyping and Scripting Basics.

UNIT 2: **10 lecture hours**
Terrain, Terrain Assets, Camera, Layer, Game Physics, Collider, Gravity simulation, Rigid body interaction, Collisions, Collision Detection, resolution, Optimization Application and Techniques, Deployment methods, Character scripting, Object modelling, Texture to game objects, Sprites, Animation.

UNIT 3: **8 lecture hours**
Association of audio, Audio assets, Different audio formats, Audio mixing, visual continuity in tiles, Adding objects to scene, Prefabs, Lighting, RGB space, Transparency, Level design, Scenes, Tiles, Combinatorial games, Two-person zero-sum games, Zero-sum games on graphs, General-sum games, Adaptive decision making, Artificial Intelligence Agents, Navigation and pathfinding.

Laboratory:
3D game development walkthrough on Unity, Maya, Audio Listeners and Sources on Unity, Learning C++ with SDL library and developing gaming programs and modules with C++.

Text Book:
1. Jesse schell, The Art of Game Design: A Book of Lenses (3rd ed.), A K Peters/CRC Press, 2019. ISBN 00000.

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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 Computer Applications				
BCAP356	Special Topics in Gaming	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

By the end of this program, students should have the following knowledge, skills, and values:

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 animation and gaming.

Course Contents:

UNIT 1: **28 lecture hours**

This course covers the cutting-edge topics in animation and gaming, and these modules will be chosen by the instructor based on the requirements and relevance at that point of time. These modules 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 modules.

Laboratory:

Students will gain practical experience by using tools and technologies related to animation and gaming.

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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 Computer Applications				
BCAP357	Android Application using Kotlin	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: **3 lecture hours**
Kotlin basics, functions, classes and objects, OOPs, extensions

UNIT 2: **3 lecture hours**
Build your android application, basic app anatomy, layout: linear layout, add user interactivity, constraint layout, data binding basics, application navigation

UNIT 3: **6 lecture hours**
Android app architecture, activity and fragment lifecycle, view model, live data, live data transformation, persistence, connect to the internet, repository pattern and work manager

UNIT 4: **2 lecture hours**
App designing, styles and themes, material design, dimension and colors

Laboratory:

Students will develop the android application using latest tools of kotlin.

Text Book:

1. *The Android Development with Kotlin course is already published online for self-paced learning.*

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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 Computer Applications				
BCAP358	Modern and Contemporary Application in Computer 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 the skills to identify and apply modern and contemporary technologies to solve real-world computer science problems.

CO2. Become familiar with programming languages and software tools related to Neche technologies, Analyse the advantages and disadvantages of various technologies and how they impact the world

Course Contents:

UNIT 1: **42 lecture hours**

This course will provide an overview of modern and contemporary applications of computer science. We will cover topics such as artificial intelligence, machine learning, robotics, data science, cloud computing, and more. We will explore the various technologies and techniques used in each area, as well as their real-world applications. We will also look at the ethical implications of certain applications and the importance of responsible use of computer science technology. The course will also feature programming projects and assignments to give students a practical understanding of the concepts discussed. Learning outcomes include an understanding of the fundamentals of computer science, knowledge of the various applications of computer science, and an ability to apply these concepts to real-world problems.

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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 Computer Applications**				
BCAP359	**Latest Advances in Engineering and 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. Gain an understanding of the latest engineering and technology advances, their implications, and applications.

CO2. Develop the skills necessary to analyze and apply the latest engineering and technology advances to solve engineering and technology-related problems.

Course Contents:

UNIT 1: **42 lecture hours**

This course will cover the latest advances in engineering and technology, including topics such as artificial intelligence, machine learning, robotics, control systems, Internet of Things, big data, cloud computing, and more. Students will learn about the newest technologies, their applications, and their implications for engineering and technology. They will also explore case studies and gain a better understanding of how current technologies are being used in the industry today. Students will develop their knowledge of the fundamentals of engineering and technology and learn how to apply them to solve real-world problems. Additionally, students will develop their ability to think critically and strategically about the current state of engineering and technology.

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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 Computer Applications				
BCAP360	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)

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.

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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 Computer Applications				
BCAP361	Emerging Topics in Blockchain	L	T	P	C
Owning School/Department	Computer Science and Engineering	3	0	0	3
Pre-requisites/Exposure	-				

Course Outcomes (COs)

CO1. Develop an understanding of emerging trends and technologies in Blockchain and how they are being used to solve business problems.
CO2. Identify potential use cases and applications of Blockchain-based solutions and evaluate the associated risks and benefits of implementation.

Course Contents:

UNIT 1: **28 lecture hours**

The syllabus on emerging topics in Blockchain will cover the most recent developments in the technology, including topics like distributed ledger technology, decentralized applications, cryptocurrency and smart contracts. We will discuss the different applications of blockchain technology, the benefits and challenges of using this technology, and the various ways it can be implemented. We will also look at various case studies of companies that have successfully implemented blockchain technology, as well as the potential implications for businesses and other organizations. Finally, we will also explore the potential for blockchain to be used to create new forms of digital money, and the impact this could have on the global economy.

Laboratory:
Students will gain practical experience by using tools and technologies related to Blockchain.

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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 Computer Applications				
BCAP362	Emerging Topics in Cloud 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. Students will be able to analyses emerging trends in cloud computing, such as serverless computing, containers, and edge computing.

CO2. Students will be able to evaluate the benefits and challenges of the various cloud computing models and be able to recommend the most appropriate cloud model for a specific application.

Course Contents:

UNIT 1: **28 lecture hours**

Cloud computing is a rapidly evolving field that is constantly introducing new technologies, services, and applications. Emerging topics in cloud computing include edge computing, serverless computing, blockchain, containers, and artificial intelligence. Edge computing is a distributed computing model that brings compute, storage, and networking closer to the data source. Serverless computing is a model of computing that allows developers to deploy code without worrying about provisioning and managing servers. Blockchain is a distributed ledger technology that is being used to create decentralized applications and services. Containers are an isolated, lightweight, and portable environment for running applications in the cloud. Artificial intelligence and machine learning are increasingly being used to automate tasks and provide insights from data. These emerging topics in cloud computing are transforming the way businesses operate and provide new opportunities for developers to create innovative applications and services.

Laboratory:

Students will gain practical experience by using tools and technologies related to Cloud Computing.

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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 Computer Applications				
BCAP363	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: **28 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.

Laboratory:

Students will gain practical experience by using tools and technologies related to Cyber Security.

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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 Computer Applications				
BCAP364	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 analyze large datasets using advanced analytics and machine learning techniques to gain insights and develop effective data-driven solutions.

Course Contents:

UNIT 1: **28 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.

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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 Computer Applications				
BCAP365	Emerging Topics 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. Develop an understanding of the core principles, practices, and technologies of modern DevOps, including containerization, automation, and cloud-native solutions.

CO2. Identify and implement best practices for aligning DevOps processes and tools with organizational objectives and desired outcomes.

Course Contents:

UNIT 1: **28 lecture hours**

DevOps is a rapidly growing practice that is changing the way organizations develop, deploy, and monitor software applications. It is a combination of tools, processes, and people that enables organizations to rapidly develop, test, deploy, and monitor applications in a more efficient and cost-effective manner. Emerging topics in DevOps include containerization and microservices, infrastructure automation, distributed computing, cloud computing, and DevOps Security. Containerization and microservices allow for increased scalability, flexibility, and portability, while infrastructure automation reduces the need for manual configuration and accelerates the deployment of applications. Distributed computing enables organizations to make use of multiple nodes for increased scalability and performance, and cloud computing enables organizations to take advantage of the scalability and cost benefits of cloud computing. DevOps Security is a critical element of DevOps that ensures applications are secure and compliant with regulatory requirements. With the increasing adoption of DevOps, organizations are quickly realizing the benefits of improved agility, scalability, cost savings, and security.

Laboratory:

Students will gain practical experience by using tools and technologies related to DevOps.

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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 Computer Applications				
BCAP366	Emerging Topics in 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. Understand the fundamentals of emerging technologies in Full Stack development, such as serverless computing, microservices, and containerization.

CO2. Develop the skills to deploy applications and services using the most up-to-date tools and techniques for developing robust Full Stack solutions.

Course Contents:

UNIT 1: **28 lecture hours**

Full stack web development is a broad and rapidly evolving field. As technology advances, new topics are emerging that are becoming increasingly important to full stack developers. These topics include machine learning, artificial intelligence, blockchain, cloud computing, data science, and mobile app development. Machine learning and artificial intelligence are becoming increasingly important for creating applications that can respond to user input and learn from user interactions. Blockchain is a secure and distributed ledger technology that has the potential to revolutionize the way data is stored and used. Cloud computing offers developers a way to store and access data in the cloud, as well as create applications that can be used across multiple devices and platforms. Data science is a method for extracting insights from large datasets and is becoming increasingly important for creating predictive applications. Finally, mobile app development is a key aspect of full stack development, and developers need to be able to create applications that are optimized for different devices.

Laboratory:

Students will gain practical experience by using tools and technologies related to Full Stack.

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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 Computer Applications				
BCAP367	Emerging Topics in 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. Understand the fundamentals of emerging technologies in Gaming, such as serverless computing, microservices, and containerization.

CO2. Develop the skills to deploy applications and services using the most up-to-date tools and techniques for developing robust Gaming solutions.

Course Contents:

UNIT 1: **28 lecture hours**

Gaming development is a broad and rapidly evolving field. As technology advances, new topics are emerging that are becoming increasingly important to gaming developers. These topics include machine learning, artificial intelligence, blockchain, cloud computing, data science, and mobile app development. Machine learning and artificial intelligence are becoming increasingly important for creating applications that can respond to user input and learn from user interactions. Gaming is a secure and distributed ledger technology that has the potential to revolutionize the way data is stored and used. Cloud computing offers developers a way to store and access data in the cloud, as well as create applications that can be used across multiple devices and platforms. Data science is a method for extracting insights from large datasets and is becoming increasingly important for creating predictive applications. Finally, mobile app development is a key aspect of gaming, and developers need to be able to create applications that are optimized for different devices.

Laboratory:

Students will gain practical experience by using tools and technologies related to Full Stack.

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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 Computer Applications				
BCAP368	Emerging Topics in Mobile 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. Develop basic mobile applications using the Swift programming language.
CO2. Design user interfaces and integrate device hardware functionalities in Swift-based apps.
CO3. Apply cloud connectivity and mobile security concepts in cross-platform mobile development.

Course Contents:

UNIT 1: **28 lecture hours**

The Emerging Topics in Mobile Technology using Swift module will introduce learners to the ever-evolving world of mobile technology. The module will cover the basics of developing applications for mobile devices using the Swift programming language. Learners will be exposed to key concepts such as creating user interfaces, dealing with the device hardware, connecting to the cloud, understanding mobile security, and creating mobile apps for different platforms. The module will include both lectures and hands-on labs to give learners the opportunity to practice their skills. By the end of this module, learners will have a solid understanding of the basics of mobile development and be able to apply their knowledge to their own projects

Laboratory:

Students will gain practical experience by using tools and technologies related to Mobile Technology.

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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))

Open Electives

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 Computer Applications				
BCAO401	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 I **12 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 II **12 lecture hours**

Reasoning with uncertainty, Probabilistic reasoning over time Learning Gaming: Movement, Decision Making, Strategy, Infrastructure, Agent-Based AI.

Unit III **6 lecture hours**

Hacks and Heuristics. Vision Systems: fundamentals of image formation, camera imaging geometry, feature detection and matching, Multiview geometry.

Unit IV **9 lecture hours**

Motion estimation and tracking, and classification, Action recognition Color spaces and Segmentation.

List of Experiments:

Students will be able to implement the various AI algorithms and develop a project based on gaming/image processing using Python/MATLAB/CUDA.

Text Books :

1. Stuard Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach (3 ed.)*, Prentice Hall, 2010. ISBN 978-0136042594.

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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 Computer Applications				
BCAO402	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 I **9 lecture hours**

Evolution of web technologies; Shortcomings of the traditional web; General scheme of knowledge representation models; Brief historical information on the development 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). Fuzzy sets; Definition of concepts: ontology, concept, attitude, axioms. Examples of ontologies

Unit II **8lecture hours**

The concept of Semantic Web; Multilevel representation; Semantic Web applications; Main tendencies of development of Internet technologies; Electronic commerce; 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 III **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 result forms; 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-agent technologies.

Unit IV **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 for semantic 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.

List of Experiments:

Students will model the knowledge graph using Protege tool which is an open-source ontology editor and knowledge management system. There will be Java programming using Jena library that is Apache project and java framework for building Semantic Web applications.

Text Books:

1. Liyang Yu, *Introduction to the Semantic Web and Semantic Web Services (1st ed.)*, Chapman and Hall/CRC, 2019. ISBN 9780367388979.

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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 Computer Applications				
BCAO403	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: To explain the need for IT Support Technologies.
CO2: To articulate network security and firewall concepts.

Course Contents:

Unit I **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; Creating Troubleshooting Guides; First-Line Support; Paperwork; Second- and Third-Line Support Paperwork; Engineer Paperwork; Administrative Tools; Performance Monitoring Tools; Custom Views; Task Manager; Error and Status Information; Event Details; Event Logs; Error Logs; Remote Support Tools; Remote Desktop; Remote Assistant.

Unit II **15 lecture hours**

Evolution of Computers; Aging Technology; Interface Standards; USB; Firewire; Serial; Parallel; Unix Event Catalogue; Linux Systems; Windows NT; Windows vNext; 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); Server Virtualization; Types of Server virtualization; Advantage of Server Virtualization

Unit III **16 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; Developing Security Policy; Firewall Configuration Strategies; E-mail; E-mail Protocols; Secure E-mail; Importance of Email Security; Best Practices for Email Security; IP security; Uses of IPSec; Component of IPSec; SSL; TLS; SSL certificate; Trends and Challenges in IT Support

Text Books:

2. Mike Hasley, *The IT Support Handbook: A How-To Guide to Providing Effective Help and Support to IT Users (1st ed.)*, Apress, 2019. ISBN 978- 1484251324
3. William Stallings, *Data and Computer Communications (9th ed.)*, PearsonEducation, 2010. ISBN 978-0131392052.

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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 Computer Applications				
BCAO404	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 I **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 II **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 III **10 lecture hours**

Requirement engineering, User stories, Acceptance criteria, Requirement validation and verification, UML, Behavioral UML diagrams, Structural UML diagrams.

Unit IV **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 Books:

1. R. Pressman, Software Engineering, A Practitioner's Approach (7th ed.), McGraw Hill International, 2014. ISBN 978-9339212087.
2. Sommerville, Software Engineering (10th ed.), Person Publications Publishing

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Name of Program	Bachelor of Computer Applications				
BCAO405	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 I **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 II **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 III **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 IV **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. Arvind Kumar Bansal, *Introduction to Programming Languages (1st ed.),* Chapman and Hall/CRC, 2017. ISBN 9781138460818.
2. Aditya Kanetkar and Yashavant Kanetkar, *Let Us Python (1st ed.),* BPB, 2019. ISBN 9789389845009.

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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 Computer Applications				
BCAO406	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 I **14 lecture hours**

Artificial Intelligence for Creative Expression, 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 II **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 III **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 IV **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 Books :

1. Marcus Du Sautoy, *The Creativity Code, Art and Innovation in the Age of AI (1st ed.)*, Harvard University Press, 2020. ISBN 9780674244719.

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 Computer Applications				
BCAO407	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 I **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 II **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 marginalised 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 III **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 IV **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 Books :

1. Darrell M. West and John R. Allen, *Turning Point: Policymaking in the Era of Artificial Intelligence (1st ed.)*, Brookings Institution Press, Washington, D.C, 2020. ISBN 0815738595.

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 Computer Applications				
BCAO408	Linux Apache MySQL PHP (LAMP)	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 an overall understanding of PHP programming through various server.
CO2: To build modular web applications with different frameworks.
CO3: To design and develop webpages and web sites for the needs of an organization.

Course Contents:

Unit I **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 II **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 III **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 IV **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.

List of Experiments:

Text Books :

1. Jeremy McPeak, *Beginning JavaScript (5th ed.)*, Wrox Publication, 2015. ISBN 978-1118903339.

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 Computer Applications				
BCAO409	Data Structures and Algorithms	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 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 I **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 II **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 III **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. Narasimha Karumanchi, *Data Structures and Algorithmic Thinking with Go (1st ed.)*, CareerMonk Publications, 2020. ISBN 9781949870909.
2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, *Introduction to Algorithms (4th ed.)*, The MIT Press, 2022. ISBN 9780262367505.

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 Computer Applications				
BCAO410	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 I **10 lecture hours**

Software testing, testing objectives. Principles of Software Testing, Testing and debugging, Test metrics and measurements.

Unit II **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 III **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 IV **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 Books :

1. S. Limye, *Software Testing - Principles, Techniques and Tools (1st ed.)*, McGraw Hill Education, 2017. ISBN 9780070139909.

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 Computer Applications				
BCAO411	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 I **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 II **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.

List of Experiments:

Project based learning according to computing start-up idea. Each lab has specific targets to identify the outcome of lab and evaluate them accordingly. A mentor will be assigned to each individual team for guiding them for their project (Technology and formalizing idea).

Text Books :

1. Bachir BRAHIM, *THE COLONY OF INNOVATIVE STARTUPS (1st ed.)*, Bachir BRAHIM, 2020. ISBN 9789151958740.

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 Computer Applications				
BCAO412	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 I **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 II **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.

Uint III **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 IV **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. Why Hackers Win, *Power and Disruption in the Network Society, By Patrick Burkart, Tom McCourt (1st ed.),* University of California Press, 2019. ISBN 9780520300132.
2. Jack Caravelli and Nigel Jones, *Cyber Security: Threats and Responses for Government and Business (1st ed.),* Praeger Publishers Inc, 2019. ISBN 9781440861749.

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 Computer Applications				
BCAO413	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 I **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 II **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 III **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 IV **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 Books :

1. Puneet Kumar, Vinod Kumar Jain and Dharminder Kumar, *Artificial Intelligence and Global Society: Impact and Practices (1st ed.),* CRC Press, 2021. ISBN 0367439433.

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 Computer Applications				
BCAO414	Search EngineOptimization	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 SEO campaigns.

Course Contents:

Unit I **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 II **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 III **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.

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 Computer Applications				
BCAO415	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 I **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 II **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 III **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, local SEO, Local SEO factors, Google My Business (GMB), optimize GMB Listing, Element's optimization on GMB listing, Citations, citations in Local SEO.

Unit IV **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

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 Computer Applications				
BCAO416	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 I **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 creativecommunications. Public Relations.

Unit II **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 III **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 IV **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 Books :

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.

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 Computer Applications				
BCAO417	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 I **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 experienceof the latest tools and technologies.

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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 Computer Applications				
BCAO418	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 I **84 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 openelective courses.

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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 Computer Applications				
BCAO419	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 I **84 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 Computer Applications				
BCAO420	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)

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

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 I **84 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.