RAMA UNIVERSITY

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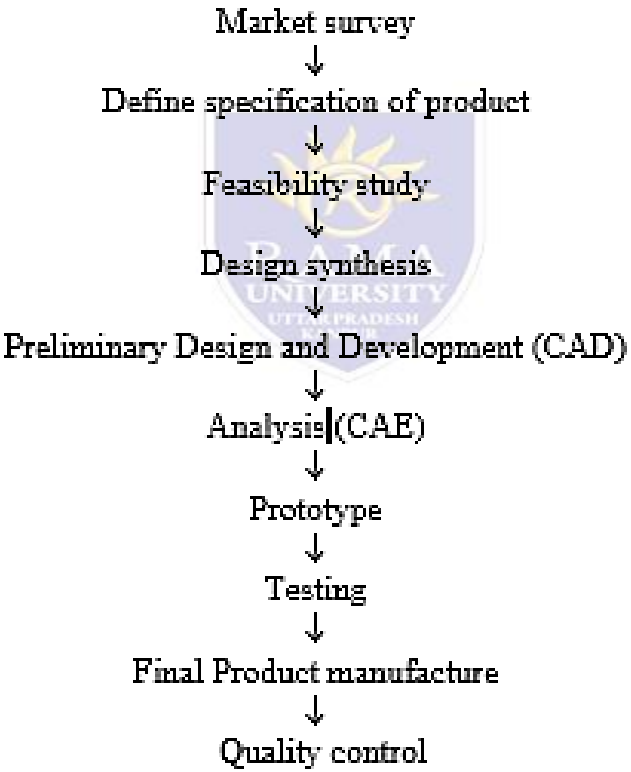
FACULTY OF ENGINEERING AND TECHNOLOGY

Lecture Machine Design

- A machine may be defined as a combination of stationary and moving parts constructed for the useful purpose of generating, transforming or utilizing mechanical energy. Machines can be classified in to:
- 1. Machines for generating mechanical energy: Converts some form of energy (electrical, heat, hydraulics etc.) into mechanical work. eg: steam engines, IC engines, water turbines etc.
- 2. Machines for transforming mechanical energy: known as converting machines. These types of machines transform mechanical energy into another form of energy. eg: Electric generators, hydraulic pumps etc.
- 3. Machines for utilizing mechanical energy: These machines receive mechanical energy and deliver and utilize it as such in the performance of useful work. eg: lathe, m/c tools etc.
- General Steps in Design Process:



Lecture Machine Design

- In the design process first comes the stage to perform the market survey to identify the need for the product, which will be done by getting feedback from the customer and the requirements of customer.
- Then according to requirements of the product the specification of the product have to be specified.
- The next stage is to perform the economic analysis which is called feasibility study of the product in the market. If found optimal with the manufacturing of the product with profit the process will be proceeded to design synthesis stage, in which the dimensions of the product will be determined.
- The design calculations will be made for development of the product and Computer aided design (CAD) made for drafting (two dimensional) and modeling (three dimensional) of the product.
- The design made will be analyzed virtually by Computer Aided Engineering (CAE) tools to understand the failure of the component and predict the life of the component.
- In the analysis stage if the component gets failed, the design calculations have to be made again iteratively till it is found safe in the analysis stage.
- After the success of the analysis stage the reduced (or) enlarged scale of the product will be fabricated and then tested by using sensors and hardware components.
- If the product is failing in the testing stage the iteration (or) recalculation of the design work should be made. If the product is found safe during testing stage then it can be preceded to Final product manufacture stage.
- After manufacturing the product it will be sent to quality control section to check the accuracy of the manufactured product,
- if the product doesn't meet the required specifications it has to be forwarded to design calculation stage and iterative steps have to be performed till the product meets the required specifications.

Lecture Machine Design

- Machine design is defi ned as the use of scientifi c
- principles, technical information and imagination
- in the description of a machine or a mechanical
- system to perform specifi c functions with maximum
- economy and effi ciency. This defi nition of machine
- design contains the following important features:
- (i) A designer uses principles of basic and
- engineering sciences such as physics,
- mathematics, statics and dynamics,
- thermodynamics and heat transfer, vibrations
- and fl uid mechanics. Some of the examples
- of these principles are
- (a) Newton's laws of motion,
- (b) D' Alembert's principle,
- (c) Boyle's and Charles' laws of gases,
- (d) Carnot cycle, and
- (e) Bernoulli's principle.
- (ii) The designer has technical information of
- the basic elements of a machine. These
- elements include fastening devices, chain, belt and gear drives, bearings, oil seals and
- gaskets, springs, shafts, keys, couplings,
- and so on. A machine is a combination of
- these basic elements. The designer knows
- the relative advantages and disadvantages of
- these basic elements and their suitability in
- different applications.
- (iii) The designer uses his skill and imagination to produce a confi guration, which is a combination of these basic elements. However, this combination is unique and different in different situations. The intellectual part of constructing a proper confi guration is creative in nature.
- (iv) The fi nal outcome of the design process
- consists of the description of the machine.
- The description is in the form of drawings of
- assembly and individual components.
- (v) A design is created to satisfy a recognised
- need of customer. The need may be to
- perform a specifi c function with maximum
- economy and effi ciency.

Lecture Machine Design

- Step 1: Product Specifi cations
- Step 2: Selection of Mechanism After careful study of the requirements, the designer prepares rough sketches of different possible mechanisms for the product. For example, while designing a blanking or piercing press, the following mechanisms are possible:
- (i) a mechanism involving the crank and connecting rod, converting the rotary motion of the electric motor into the reciprocating motion of the punch;
- (ii) a mechanism involving nut and screw, which is a simple and cheap confi guration but having poor effi ciency; and
- (iii) a mechanism consisting of a hydraulic cylinder, piston and valves which is a costly confi guration but highly effi cient.

- Step 3: Layout of Configuration a block diagram showing the general layout of the selected confi guration. For example, the layout of an Electrically-operated Overhead Travelling (EOT) crane will consist of the following components:
- (i) electric motor for power supply;
- (ii) fl exible coupling to connect the motor shaft to the clutch shaft;
- (iii) clutch to connect or disconnect the electric motor at the will of the operator;
- (iv) gear box to reduce the speed from 1440 rpm to about 15 rpm;
- (v) rope drum to convert the rotary motion of the shaft to the linear motion of the wire rope;
- (vi) wire rope and pulley with the crane hook to attach the load; and (vii) brake to stop the motion.

- Step 4: Design of Individual Components The design of individual components or machine elements is an important step in a design process. It consists of the following stages:
- (i) Determine the forces acting on the component.
- (ii) Select proper material for the component depending upon the functional requirements such as strength, rigidity, hardness and wear resistance.
- (iii) Determine the likely mode of failure for the component and depending upon it, select the criterion of failure, such as yield strength, ultimate tensile strength, endurance limit or permissible defl ection.
- (iv) Determine the geometric dimensions of the component using a suitable factor of safety and modify the dimensions from assembly and manufacturing considerations.