CBCS SCHEME

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18ME61

Sixth Semester B.E. Degree Examination, Dec.2024/Jan.2025
Finite Element Methods

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Explain different steps involved in Finite Element Analysis. **(08 Marks)**

b. State the principle of minimum potential energy. Using principle of minimum potential energy, determine the nodal displacements for the spring system shown in the Fig.Q.1(b). Take $F_1 = 75$ N and $F_2 = 100$ N. **(12 Marks)**

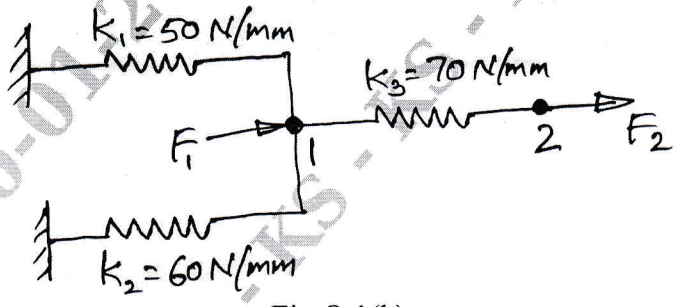


Fig.Q.1(b)

OR

2 a. Briefly explain the node numbering scheme in finite element analysis. **(06 Marks)**

b. Use Rayleigh-Ritz method to find stress at mid point of a bar shown in the Fig.Q.2(b). Take E = 70 GPa, A = 100 mm^2. Assume the displacement model to be a second order polynomial. **(14 Marks)**

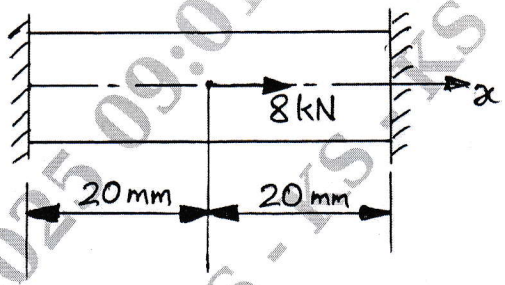


Fig.Q.2(b)

Module-2

3 a. Derive the shape functions for Constant Strain Triangular (CST) element in global coordinates. **(08 Marks)**

b. Fig.Q.3(b) shows a one dimensional bar subjected to an axial load. Taking it as a two bar element, determine the nodal displacements. Take E = 200 GPa and A = 10^4 mm^2. **(12 Marks)**

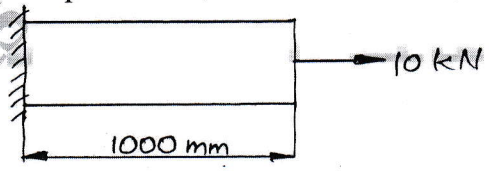


Fig.Q.3(b)

OR

4 a. Derive the shape functions for an isoparametric linear bar element in natural coordinate system. **(06 Marks)**

b. Determine the nodal displacements and stresses in each element for the two bar truss shown in the Fig.Q.4(b). **(14 Marks)**

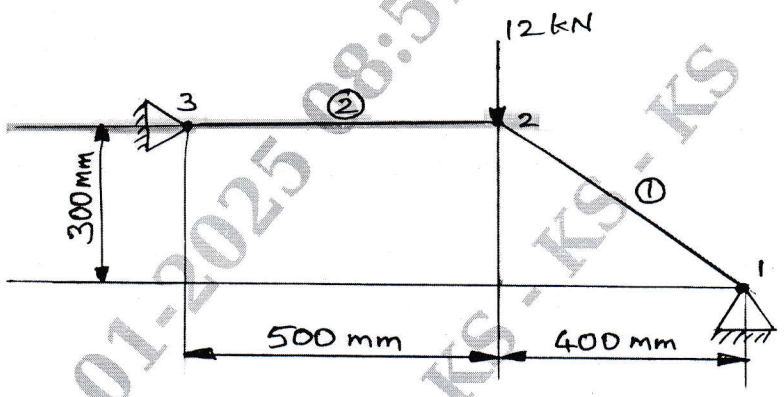


Fig.Q.4(b)

Module-3

5 a. Derive the elemental stiffness matrix for a beam element. **(10 Marks)**

b. For the beam element shown in Fig.Q.5(b) determine deflection under the given load. Take $E = 2 \times 10^5$ N/mm^2 and $I = 4 \times 10^{-6}$ m^4. **(10 Marks)**

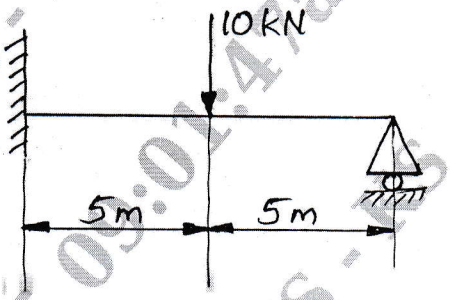


Fig.Q.5(b)

OR

6 a. Derive the shape function of a shaft element under pure torsion. **(06 Marks)**

b. Determine the angle of twist at the free end of a shaft subjected to a torque of 100 kN-m as shown in the Fig.Q.6(b). Given G = 80 GPa. Also determine the angle of twist at the center. **(14 Marks)**

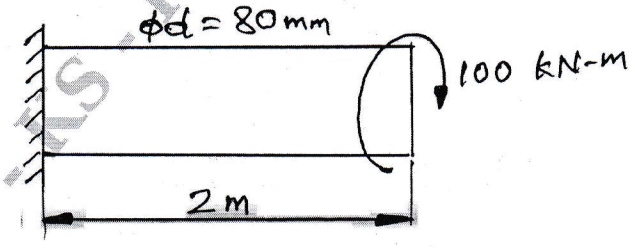


Fig.Q.6(b)

Module-4

7 a. Explain the rate equations for three modes of heat transfer. **(06 Marks)**

b. Find the temperature distribution in the one dimensional fin shown in Fig.Q.7(b).

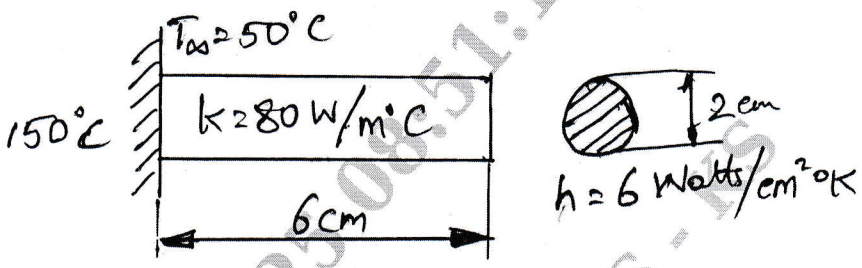


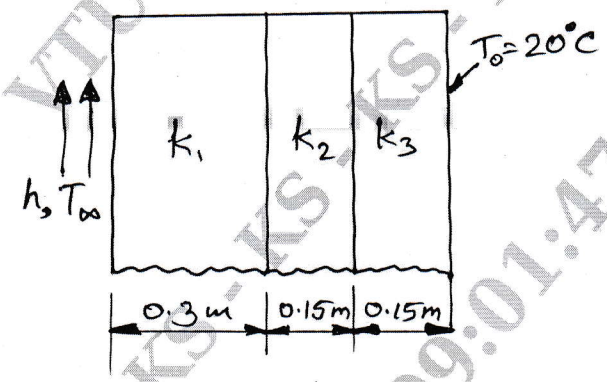
Fig.Q.7(b)

(14 Marks)

OR

8 a. Derive element conductivity matrix, element convection matrix and element heat flux vector for a two noded one dimensional fin. **(08 Marks)**

b. Solve for temperature distribution in the composite wall shown in the Fig.Q.8(b). Use penalty approach of handling boundary conditions. **(12 Marks)**



$K_1 = 20$ W/m°C
$K_2 = 30$ W/m°C
$K_3 = 50$ W/m°C
$h = 25$ W/m²°C
$T_\infty = 800°C$

Fig.Q.8(b)

Module-5

9 a. Derive the stiffness matrix for an axisymmetric element using potential energy approach. **(10 Marks)**

b. Derive lumped mass matrix and consistent mass matrix for a bar element. **(10 Marks)**

OR

10 a. Calculate the eigen values and eigen vectors for the matrix $[A] = \begin{bmatrix} 8 & 1 \\ 1 & 2 \end{bmatrix}$. **(10 Marks)**

b. Derive the shape function for an axisymmetric triangular element. **(10 Marks)**

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18ME62

Sixth Semester B.E. Degree Examination, Dec.2024/Jan.2025
Design of Machine Elements – II

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of design data hand book is permitted.
3. Assume suitable missing data.

Module-1

1 a. A helical spring is made from a 8 mm diameter wire and has an outer diameter of 100 mm. if the permissible shear stress is 420 MPa and modulus of rigidity is 84 GPa. Find the axial load the spring can carry and the deflection per active turn :
(i) Neglecting curvature effect.
(ii) Considering curvature effect. **(10 Marks)**

b. A semi elliptical laminated leaf spring with two full length leaves and ten graduated leaves are to be designed to support a central load of 6 KN over two points 1000 mm apart. The central band width is 100 mm. The ratio of total depth of the spring to its width is 2.5. The design normal stress (pre-stress) of the material of the leaves is 400 MPa and the modulus of elasticity is 208 GPa. Determine,
(i) Width and thickness of the leaves.
(ii) The initial gap between full length and graduated leaves.
(iii) The central bolt load **(10 Marks)**

OR

2 a. A belt 125 mm wide and 10 mm thick is transmiting power at 900 m/min. The net driving tension is 2 times the tension on slack side. If safe permissible stress on the belt is 1.5 MPa. Calculate the power that can be transmitted at this speed. Take density of belt material as 1000 kg/m^3. Also find the maximum power that can be transmitted by this belt and the velocity at which this can be transmitted. **(10 Marks)**

b. A 8×19 steel wire rope is to hoist 50 KN of load from a depth of 1000 m. Determine the number of ropes required if the maximum speed is 2.5 m/s and acceleration is 1.25 m/sec^2 assuming the rope is made of 25 mm diameter. Neglect the weight of the tackle. **(10 Marks)**

Module-2

3 a. Derive the Lewis equation for the beam strength of a spur gear tooth. Also list the assumptions made. **(04 Marks)**

b. Specify the details of a spur gear to transmit 20 kW at 120 rpm. The teeth are of 20° full depth involute system having 16 teeth on pinion and a speed ratio of 3 : 1. Assume that the starting torque is 20% more than the mean torque. Both gears are made of steel C45, untreated with $\sigma_d = 233.4$ MPa and BHN 200. **(16 Marks)**

OR

4 a. Define formative number of teeth in helical gears and derive the expression for the same. **(04 Marks)**

b. A compressor running at 350 rpm is driven by a 120 kW motor running at 1400 rpm. The center distance is 400 mm and helix angle is 25°. The motor pinion is made of forged steel and the driven gear is cast steel. Design the gear pair using 20° FDI system. The pinion has 20 teeth. **(16 Marks)**

Module-3

5 A pair of 20° pressure angle bevel gears is used to transmit power between two perpendicular shafts. The pinion rotates at 600 rpm with a module of 8 mm and has 30 teeth while gear has 60 teeth. If both gears are made of steel having design strength of 200 MPa, determine the power that can be transmitted based on,

(i) Bending strength,

(ii) Surface endurance strength if Fen = 1.25 Fd.

Assume 8 to 10 hours service per day with medium shocks and $\hat{e}n$ =350 MPa. **(20 Marks)**

OR

6 Design a worm gear drive for a speed reduction ratio of 25. The pinion rotates at 600 rpm and transmits 35 kW. Worm is made of C30 heat treated steel $(\sigma_{d_1} = 220.6\,\text{MPa})$ and gear of phosphor bronze $(\sigma_{d_2} = 82.4\,\text{MPa})$ **(20 Marks)**

Module-4

7 a. A multiple disc clutch of steel on bronze category is to tranmit 4 kN at 750 rpm. The inner diameter of contact is 80 mm and the outer diameter of contact is 140 mm. The clutch operates in oil with a co-efficient of friction of 0.1. The average allowable maximum pressure is 0.35 MPa. Assume uniform wear theory and determine,

(i) Number of steel and bronze discs.

(ii) Axial force required. **(10 Marks)**

b. A cone clutch transmits 180 N-m of torque at 1200 rpm. The larger diameter of the clutch is 300 mm and face angle of the cone is 12.5° with a face width of 60 mm and $\mu = 0.2$. Determine

(i) Axial force required to transmit the torque.

(ii) Axial force required to engage the clutch.

(iii) Average normal pressure when maximum torque is transmitted.

(iv) Maximum and minimum normal pressures. **(10 Marks)**

OR

8 a. A cast iron disc of 0.9 m in diameter and 200 mm thick is used as a fly wheel which rotates at 400 rpm. It is brought to rest in 2.2 sec by means of a brake. Calculate

(i) Energy absorbed by the brake.

(ii) Torque capacity of the brake.

(iii) Number of turns. Take density of CI as 7200 kg/m^3 and radius of gyration = 0.125 m. **(10 Marks)**

b. A simple band brake as shown in Fig.Q8 (b) is to be designed to absorb a power of 30 kN at a rated speed of 750 rpm. Determine
   (i) The effort required to stop clockwise rotation of the brake drum.
   (ii) The effort required to stop counter clockwise rotation of the brake drum.
   (iii) The dimensions of the rectangular cross-section of the brake lever assuming its depth to be twice the width.
   (iv) The dimensions of the cross section of the band assuming its width to be ten times the thickness. **(10 Marks)**

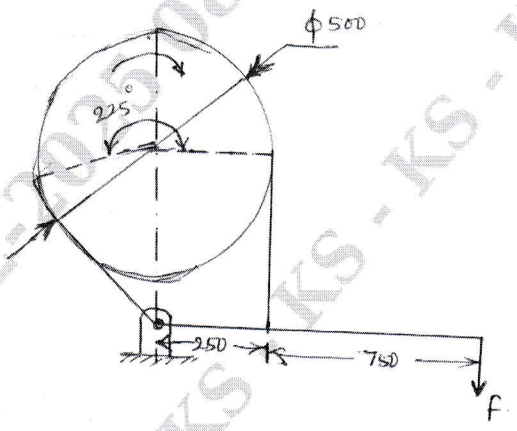

Fig. Q8 (b)

Module-5

9 a. Derive Petroff's equation for a lightly loaded bearing. **(06 Marks)**

b. Explain the formation of continuous oil film in Journal bearing. **(04 Marks)**

c. A full Journal bearing of diameter 80 mm and 120 mm long supports a radial load of 6000 N. The shaft rotates at 600 rpm and r/c = 1000. The room temperature is 30 °C and the surface of the bearing is limited to 60 °C. Determine the viscosity of the oil to satisfy the above requirements if the bearing is well ventilated and if no artificial cooling is required. Also determine the temperature of the oil. **(10 Marks)**

OR

10 a. Define the following :
   (i) Static load
   (ii) Dynamic load
   (iii) Bearing life
   (iv) Rating life **(06 Marks)**

b. What change in the loading of Rolling contact bearing will cause the expected life to be doubled? Derive the condition. **(04 Marks)**

c. A bell bearing is operating on a work cycle consisting of three parts namely Radial load of 2500 N at 1420 rpm for one quarter cycle, radial load of 1000 N at 710 rpm for one half cycle, radial load of 5000 N at 1420 rpm for remaining cycle. The expected bearing life is 10,000 hrs. Calculate the dynamic load capacity of the bearing. **(10 Marks)**

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18ME63

Sixth Semester B.E. Degree Examination, Dec.2024/Jan.2025
Heat Transfer

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of heat transfer data hand book and steam tables are permitted.

Module-1

1 a. Explain briefly : (i) Thermal conductivity (ii) Thermal diffusivity. **(05 Marks)**

b. Write down three-dimensional heat conduction equation for Cartesian co-ordinates, write the Poisson's, Laplace, Fourier equations and one-dimensional equation for the same. **(05 Marks)**

c. The interior of a refrigerator having inside dimension $0.5m \times 0.5m$ base area and 1 m height, is to be maintained at $6^{\circ}C$. The walls of the refrigerator are constructed with two mild steel sheets of 3 mm thick ($K = 46.5\ W/m^{\circ}C$) and with 50 mm of glass wall insulation ($K = 0.046\ W/m^{\circ}C$) between them. If the average heat transfer coefficient at the outer and inner surfaces are $11.6\ W/m^{2\circ}C$ and $14.5\ W/m^{2\circ}C$ respectively. Calculate

(i) The rate at which heat must be removed from the interior to maintain the specified temperature in the kitchen at $25^{\circ}C$.

(ii) Temperature on the outer surface of the metal sheet. **(10 Marks)**

OR

2 a. What is meant by Boundary condition? Explain. **(05 Marks)**

b. Discuss the design aspects for providing insulation scheme for cable wire and steam pipes. **(05 Marks)**

c. A wall of a furnace is made up of inside layer of silica brick 120 mm thick covered with a layer of magnesite brick 240 mm thick. The temperatures at the inside surface of silica brick wall and outside surface of magnesite brick wall are $725^{\circ}C$ and $110^{\circ}C$ respectively. The contact thermal resistance between the two walls at the interface is $0.0035^{\circ}C/W$ per unit wall area. If the thermal conductivities of silica and magnesite bricks are $1.7\ W/m^{\circ}C$ and $5.8\ W/m^{\circ}C$. Calculate

(i) The rate of heat loss per unit area of walls.

(ii) The temperature drop at the interface. **(10 Marks)**

Module-2

3 a. Derive the differential equation governing the temperature distribution for a fin of a uniform cross section by assuming thermal conductivity, the heat transfer co-efficient and ambient temperature being constant. **(10 Marks)**

b. In a thermal conductivity measuring experiments two identical rods are used. One of the rod is base aluminium ($K = 200\ W/mK$). The other rod is a specimen. One end of both the rod is fixed to a wall at $100^{\circ}C$. While other end is suspended in air at $25^{\circ}C$. The steady temperature at the same distance along the rods were measured and found to be $75^{\circ}C$ on aluminium and $60^{\circ}C$ on specimen rod. Find the thermal conductivity of specimen rod, if the fin tip is insulated. **(10 Marks)**

OR

4 a. What is lumped parameter analysis? Prove that the temperature distribution in a body at time 't' during Newtonian heating or cooling is given by $\frac{T - T_{\infty}}{T_i - T_{\infty}} = e^{-B_i F_o}$, where T_i is temperature at time $t = 0$. **(10 Marks)**

b. An apple which can be considered as sphere of 8 cm diameter is initially at a uniform temperature of 25°C is put into a freezer at −15°C. The heat transfer co-efficient between the surface of the apple and surrounding in the freezer is 15 $\omega/m^{2^\circ}C$. The thermo-physical properties of apple are given to be,
density = 840 kg/m^3, Specific heat = 3.6 kJ/kg°C
Thermal conductivity = 0.513 W/m°C and Thermal diffusivity = 1.3×10^{-7} m^2/s
Determine (i) Centre temperature of apple after 1 hour.
(ii) Surface temperature of apple at that time.
(iii) Amount of heat transferred from the apple. **(10 Marks)**

Module-3

5 a. Explain the following : (i) Solid angle (ii) Shape factor (iii) Irradition (iv) Absorptivity (v) Emissive power **(10 Marks)**

b. Consider two large parallel plates one at 100 K with emissivity 0.8 and other is at 300 K having emissivity 0.6. A radiation shield is placed between them. The shield has emissivity as 0.1 on the side facing hot plate and 0.3 on the side facing cold plate. Calculate percentage reduction in radiation heat transfer. **(10 Marks)**

OR

6 a. Explain formulation of differential equation 1D steady heat conduction. **(10 Marks)**

b. Explain application and computational error of numerical analysis heat conduction. **(10 Marks)**

Module-4

7 a. Explain velocity and thermal boundary layer. **(10 Marks)**

b. Consider the body of a mass has vertical cylinder with 300 mm dia and 170 cm height. Calculate heat generated by the body in 1 day. Take body temperature as 36°C and ambient temperature as 14°C. **(10 Marks)**

OR

8 a. Using dimensional analysis, obtain fundamental relation between dimensionless parameter in forced convection. **(10 Marks)**

b. A long 10 cm dia steam pipe whose external surface temperature is 110°C passes through some open area. Determine the rate of heat loss from pipe per unit of its length when air is at 1 atm pressure and 10°C. The wind is blowing across the pipe at velocity 8 m/s. **(10 Marks)**

Module-5

9 a. Obtain expression for LMTD for parallel flow heat exchanger. **(10 Marks)**

b. The flow rate of hot and cold flux stream running through a parallel heat exchanger are 0.2 kg/s and 0.2 kg/s respectively. The inlet temperature of hot and cold sides are 75°C and 20°C respectively. The Exit temperature of hot water is 45°C. If Individual heat transfer coefficient on both sides are 650 W/m^{2}C. Calculate area of heat transfer. **(10 Marks)**

OR

10 a. Sketch and explain boiling curve. **(10 Marks)**

b. Saturated steam at 80°C condenses as film on a vertical plate at a temperature of 70°C. Calculate Heat transfer coefficient and rate of condensation. Assume Latent heat of vapourization at 80°C as 2309 kJ/kg. **(10 Marks)**

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18ME641

Sixth Semester B.E. Degree Examination, Dec.2024/Jan.2025
Non Traditional Machining

Time: 3 hrs. Max. Marks: 100

Note: 1. ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Use neat sketch wherever necessary.***

Module-1

1 a. Define Nontraditional Machining. Discuss the physical parameters of NTM process. **(06 Marks)**

b. What is the difference between conventional and nonconventional machining process. **(08 Marks)**

c. Explain the need of NTM process in modern industry. **(06 Marks)**

OR

2 a. What are the advantages, limitations and applications of nontraditional machining process? **(12 Marks)**

b. How modern machining process are classified? **(08 Marks)**

Module-2

3 a. Explain with neat sketch construction and working of usm process. **(10 Marks)**

b. What are advantages, limitations and applications of Abrasive Jet Machining process? **(10 Marks)**

OR

4 a. Explain with neat sketch AJM process. **(10 Marks)**

b. Explain the following parameters with respect to usm process.
i) Effect of amplitude and frequency of vibration
ii) Effect of grain diameter
iii) Effect of applied static load
iv) Effect of slurry **(10 Marks)**

Module-3

5 a. Draw schematic sketch of Electro Chemical Machining process and discuss the elements of ECM process. **(10 Marks)**

b. Explain the elements of process :
i) Maskants or resists in CHM(Chemical Machining)
ii) Etchants **(10 Marks)**

OR

6 a. Discuss the Economics of ECM Process **(04 Marks)**

b. Calculate the metal removal rate and electrode feed rate when iron is electro chemically machined using copper electrode and sodium chloride solution (Specific resistance = 5.0 ohm.cm), the power supply data of electro chemical machine used are :
Supply voltage = 18 V-DC
- Current = 5000 Amps
- Tool gap = 0.5mm
- Atomic weight of iron is 56
- Valency = 2
- Density = 7.87×10^6 gm/m^3 **(06 Marks)**

c. What are the advantages, disadvantages and applications of Chemical Machining Process (CHM). **(10 Marks)**

Module-4

7 a. Explain the mechanism of metal removal in EDM with a neat sketch. **(06 Marks)**

b. List the application of Plasma Arc Machining (PAM). **(04 Marks)**

c. Mention the properties of dielectric fluid and explain various methods of circulating the dielectric fluid. **(10 Marks)**

OR

8 a. What are the various types of torches used in plasma arc machining? Explain their operation. **(08 Marks)**

b. Explain the word "Plasma". Explain how it is used for material removal process with neat sketch. **(08 Marks)**

c. Discuss the parameter to choose electrode material in EDM process. **(04 Marks)**

Module-5

9 a. Explain the generation and control of electron beam with a neat sketch. Also discuss the material removal process. **(08 Marks)**

b. List the advantages of Laser Beam Machining (LBM). **(06 Marks)**

c. Compare thermal and non-thermal metal removal process in electron beam machining. **(06 Marks)**

OR

10 a. List the limitation of Electron Beam Machining. **(04 Marks)**

b. Explain the principle and operation of Laser beam machining with a neat sketch. **(08 Marks)**

c. Explain the different theories associated with electron beam machining. **(08 Marks)**

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