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15ME61

Sixth Semester B.E. Degree Examination, July/August 2021
Finite Element Analysis

Time: 3 hrs. Max. Marks: 80

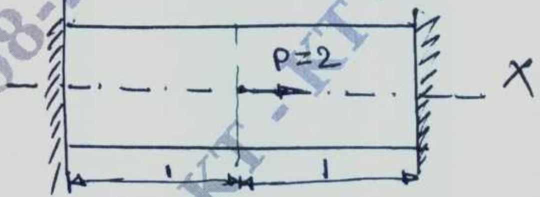
Note: Answer any FIVE full questions.

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

1 a. Explain the basic steps in the finite element methods. **(06 Marks)**

b. State principle of minimum potential energy. **(02 Marks)**

c. Fig.Q1(c) shows a bar fixed at both ends subjected to an axial load as indicated. Determine the displacement at loading point using Rayleigh-Ritz method.



E = 1, A = 1

Fig.Q1(c) **(08 Marks)**

2 a. Explain the plane stress and plane strain problems with examples. **(05 Marks)**

b. Using principle of minimum potential energy determine the displacement at the nodes for a spring system shown in Fig.Q2(b). Take $K_1 = 40$ N/m, $K_2 = 60$ N/m, $K_3 = 80$ N/m, $F_1 = 60$ N, $F_2 = 50$ N.

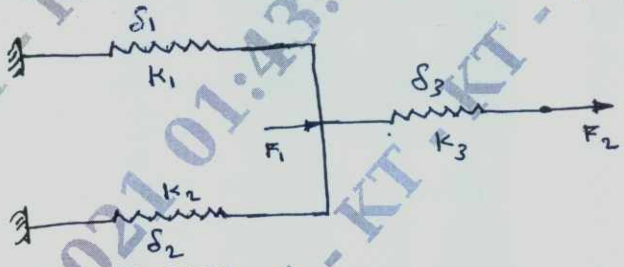
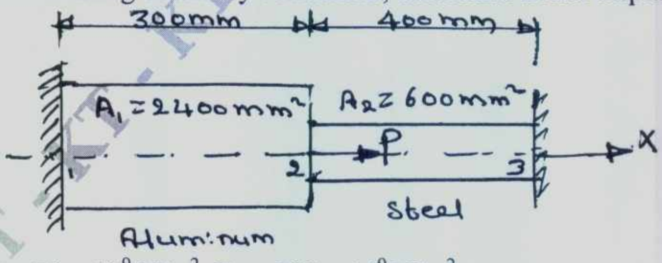


Fig.Q2(b) **(08 Marks)**

c. State and explain the convergence requirement for the finite element solution. **(03 Marks)**

3 a. The bar shown in Fig.Q3(a), an axial load $P = 200 \times 10^3$ N is applied as shown, using the penalty approach for handling boundary conditions, determine nodal displacements.



$E_1 = 70 \times 10^9$ N/m², $E_2 = 200 \times 10^9$ N/m²

Fig.Q3(a) **(10 Marks)**

b. Derive shape functions for CST element. **(06 Marks)**

4 a. Explain briefly the iso-parametric, sub parametric and super-parametric elements. **(06 Marks)**

b. For the two bar truss shown in Fig.Q4(b), determine nodal displacements element. Take E = 200 GPa, area of each bar = 1000 mm^2

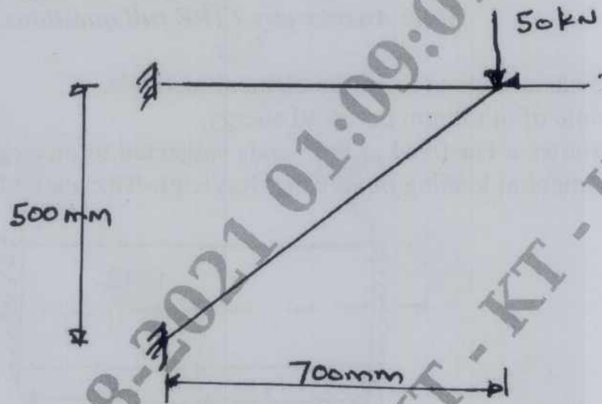


Fig.Q4(b) **(10 Marks)**

5 a. Derive Hermit shape function for beam element. **(06 Marks)**

b. For the beam and loading shown in Fig.Q5(b), determine the slopes at 2 and 3 and the vertical deflection at the midpoint of the distributed load. Take E = 200 GPa, $I = 4 \times 10^6\ mm^4$.

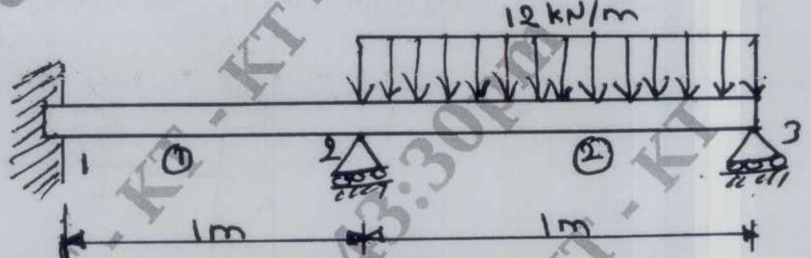


Fig.Q5(b) **(10 Marks)**

6 a. Derive stiffness matrix for the beam element. **(06 Marks)**

b. A bar of circular cross section having a diameter of 50 mm is firmly fixed at its ends and subjected to a torque at B and C as shown in Fig.Q6(b). Determine maximum angle of twist and shear stresses. Take $G = 7 \times 10^4\ N/mm^2$ and $E = 2 \times 10^5\ N/mm^2$.

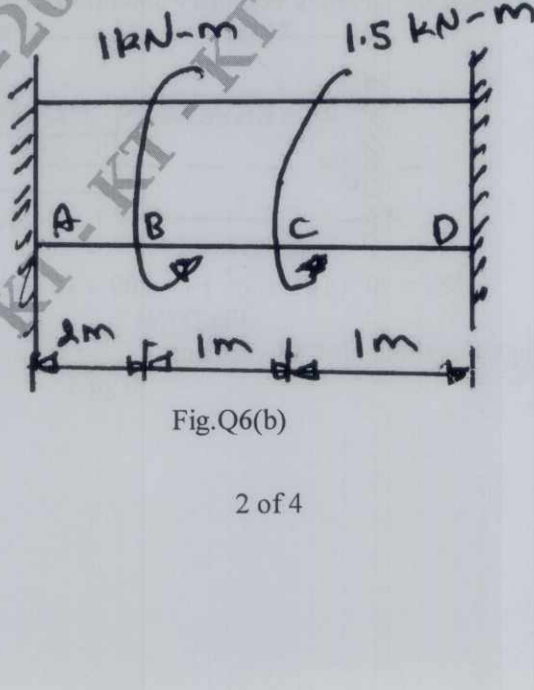
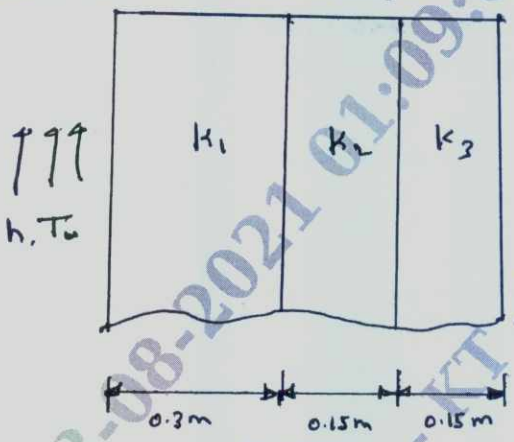


Fig.Q6(b) **(10 Marks)**

7 a. Discuss the Galerkin approach for 1-D heat conduction problem. **(06 Marks)**

b. A composite wall consists of three materials, as shown in Fig.Q7(b). The outer temperature is $T_0 = 20°C$. Convection head transfer takes place on the inner surface of the wall with $T_\infty = 800°C$ and $h = 25\ W/m^2$. Determine temperature distribution in the wall.



$T_0 = 20°C$
$K_1 = 20\ W/m°C$
$K_2 = 30\ W/m°C$
$K_3 = 50\ W/m°C$
$h = 25\ W/m^2°C$
$T_\infty = 800°C$

Fig.Q7(b) **(10 Marks)**

8 a. Derive the stiffness matrix for one dimensional fluid element. **(06 Marks)**

b. For the smooth pipe shown in Fig.Q8(b) with uniform cross section of 1 m^2, determine the flow velocities at the centre and right end, knowing the velocity at the left is $V_x = 2$ m/sec.

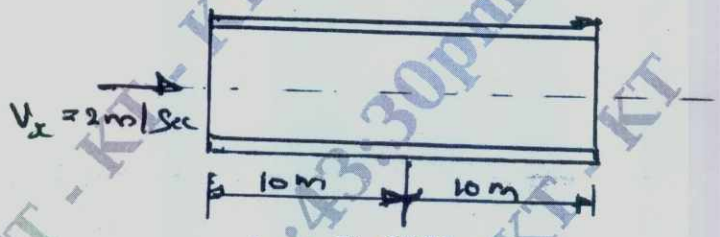


Fig.Q8(b) **(10 Marks)**

9 In Fig.Q9, a long cylinder of inside diameter 80 mm and outside diameter 120 mm snugly fits in a hole over its length. The cylinder is then subjected to an internal pressure 2 MPa. Using two elements on the 10 mm length, find the displacements at the inner radius. Take $E = 200$ GPa, $\gamma = 0.3$.

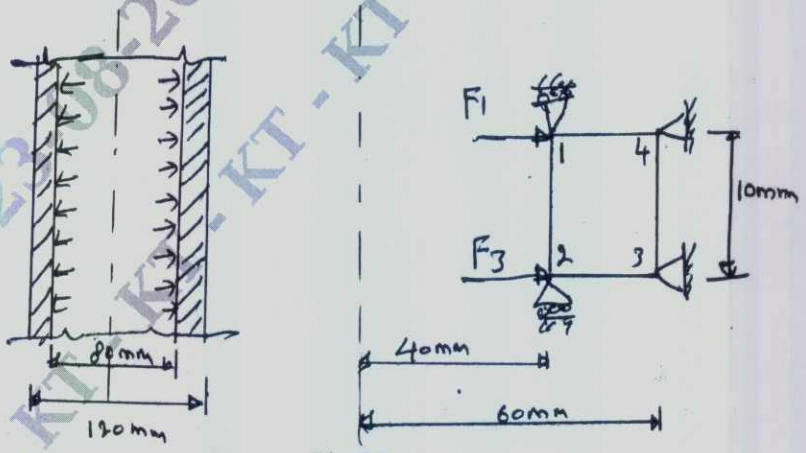


Fig.Q9 **(16 Marks)**

10 Evaluate eigen vectors and eigen values for the stepped bar shown in Fig.Q10. Take E = 200 GPa specific weight 7850 kg/m^3. Draw mode shapes. Take A_1 = 400 mm^2 and A_2 = 200 mm^2.

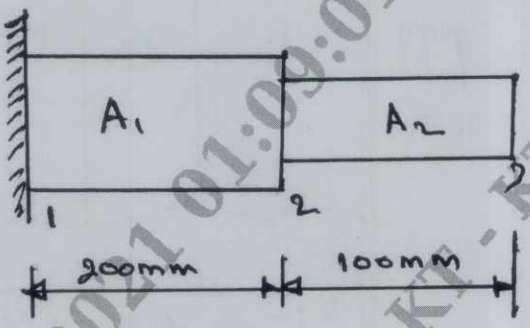


Fig.Q10 **(16 Marks)**

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15ME63

Sixth Semester B.E. Degree Examination, July/August 2021
Heat Transfer

Time: 3 hrs. Max. Marks: 80

Note: 1. ***Answer any FIVE full questions.***
2. ***Use of heat transfer data hand book is permitted.***

1 a. Define the following giving units : (i) Overall heat transfer coefficient. (ii) Radiations heat transfer coefficient. (iii) Thermal resistance. **(06 Marks)**

b. A composite slab is made of two layers of different materials A and B such that, layer A has conductivity as $K_A = 0.5(1+0.08T)$ and is 5 cm thick, while the layer B has conductivity 24 W/mK and is 2 cm thick. The exposed surface of layer A is insulated while that of the layer B is exposed to the fluid at 20°C where the heat transfer coefficient is 30 W/m^2K. If the temperature at the interface between the two layers is 70°C, find
(i) Rate of heat flux from the slab to fluid. (ii) Maximum temperature in the system.
(iii) Distance of a point at 80°C from insulated surface. **(10 Marks)**

2 a. Explain in brief the terms initial and boundary conditions. What are the boundary conditions of I, II and IIIrd kinds. **(06 Marks)**

b. A square plate heater size (15 cm × 15 cm) is inserted between two slabs, slab A is 2 cm thick (K = 50 W/mK) and slab B is 1 cm thick (K = 0.2 W/mK). The outside heat transfer coefficient on both sides of A and B are 200 and 50 W/m^2K respectively. The temperature of surrounding air is 25°C. If the rating of the heater is 1 kW, find
(i) Maximum temperature in the system. (ii) Outer surface temperature of two slabs.
Draw equivalent electrical circuit of system. **(10 Marks)**

3 a. Obtain an expression for the critical radius of insulation for a spherical shell. Give a physical explanation for the fact that certain thickness of insulation may increase the rate of heat loss rather than reduce it. **(06 Marks)**

b. Differentiate between effectiveness and efficiency of fin. **(02 Marks)**

c. Two rods A and B of equal diameter and equal length, but of different materials are used as fins. Both the rods are attached to a plain wall maintained at 160°C, while they are exposed to air at 30°C. The end temperature of rod A is 100°C, while that of the rod is 80°C. If the thermal conductivity of rod A is 380 W/mK, calculate the thermal conductivity of rod B. This fin can be assumed as short with end insulated. **(08 Marks)**

4 a. Obtain an expression for the instantaneous heat transfer and total heat transfer for lumped heat analysis treatment of unsteady state heat conduction problem. **(08 Marks)**

b. A metallic sphere of radius 10 mm is initially at a uniform temperature of 400°C. It is heat treated by first cooling it in air (h = 10 W/m^2K) at 20°C until its central temperature reaches 335°C. It is then quenched in a water bath at 20°C with h = 6000 W/m^2K until the centre of the sphere cools from 335°C to 50°C. Compute the time required for cooling in air and water for the following physical properties of the sphere:
$\rho = 3000$ kg/m^3, $C_p = 1000$ J/kgK, K = 20 W/mK, $\alpha = 6.66 \times 10^{-6}$ m^2/sec. **(08 Marks)**

5 a. An iron rod L = 5 cm long of diameter D = 2 cm with thermal conductivity K = 50 W/m°C protrudes from a wall and is exposed to an ambient at $T_\infty = 20$°C and h = 100 W/m^2°C. The base of the rod is at $T_o = 320$°C and its tip is insulated. Assuming one dimensional steady state heat flow, calculate the temperature distribution along the rod and the rate of heat loss into the ambient by using finite differences. **(12 Marks)**

b. Explain the graphical method of solving two dimensional heat conduction problems. **(04 Marks)**

6 a. For a black body enclosed in a hemispherical space, prove that emissive power of the black body is π times the intensity of radiation. **(08 Marks)**

b. Consider two large parallel plates, one at 1000 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, as a result of radiation shield. **(08 Marks)**

7 a. With reference to fluid flow over a flat plate, discuss the concepts of velocity boundary layer and thermal boundary layer with necessary sketches. **(06 Marks)**

b. Air at 20°C and at a atmospheric pressure flows over a flat plate at a velocity of 3 m/sec. If the plate is 30 cm length and at a temperature of 60°C, calculate

(i) Velocity and thermal boundary layer thicknesses at 20 cm

(ii) Average heat transfer coefficient and total drag force over the entire plate per unit width.

Take the following properties of air $\rho = 1.18\ kg/m^3$, $\gamma = 17 \times 10^{-6}\ m^2/sec$, K = 0.0272 W/mK, C_P = 1.007 kJ/kgK, P_r = 0.705 **(10 Marks)**

8 a. Water is heated while flowing through a circular pipe of 2.1 cm diameter, with a velocity of 1.2 m/sec. The entering temperature of water is 40°C and the tube wall is maintained at 80°C. Determine the length of the tube required to raise the temperature of water to 70°C. Properties of water at mean bulk temperature of 55°C are,

$\rho = 985.5\ kg/m^3$; $C_p = 4.18 kJ/kgK$, $\gamma = 0.517 \times 10^{-6}$, K = 0.654 W/mK, P_r = 3.26. **(08 Marks)**

b. A hot square plate 50 cm × 50 cm maintained at uniform temperature of $T_W = 385K$ which is placed in quiescient air at atmospheric pressure and T_∞ = 315 K. Find the heat loss from both surfaces of the plate if the plate is kept in vertical plane.

The physical properties of atmospheric air at,

$T_f = \frac{1}{2}(385 + 315) = 350\ K$ are taken as $\gamma = 2.076 \times 10^{-5}\ m^2/sec$, $P_r = 0.697$,

$K = 0.03\ W/m^\circ C$, $\beta = \frac{1}{T_f} = 2.86 \times 10^{-3} K^{-1}$. **(08 Marks)**

9 a. For a heat exchanger with equal heat capacity rates of hot and cold fluids $[(mC_P)_{hot} = (mC_P)_{cold}]$ obtain the expressions for the effectiveness of heat exchanger operating in parallel and counter flow mode as,

$\varepsilon = \frac{1 - \exp(-2NTU)}{2}$ and $\varepsilon = \frac{NTU}{NTU + 1}$ respectively. **(08 Marks)**

b. An automobile radiator has 40 tubes of inner diameter of 0.5 cm and 60 cm long in a closely spaced plate finned matrix, so that both fluids are unmixed. Hot water enters the tubes at 90°C at a rate of 0.6 kg/sec and leaves at 65°C. Air flows across the radiator through the interfin spaces and is heated from 20°C to 40°C. Calculate the overall heat transfer coefficient based on inner surface of the radiator. **(08 Marks)**

10 a. Explain the following terms as applied to heat exchangers:

(i) LMTD correction factor.

(ii) Fouling factor. **(08 Marks)**

b. Clearly explain the regimes of pool boiling with neat sketches. **(06 Marks)**

c. Differentiate between dropwise and filmwise condensation. **(02 Marks)**

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CBCS SCHEME

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15ME64

Sixth Semester B.E. Degree Examination, July/August 2021
Design of Machine Elements – II

Time: 3 hrs. Max. Marks: 80

Note: *1. Answer any FIVE full questions.*
2. Use of design data hand book is permitted.
3. Assume missing data suitably.

1 a. A ⊥ section frame for a punch press is shown in Fig.Q.1(a). Determine the capacity of press if the maximum stress in the frame is not to exceed 60N/mm^2. **(08 Marks)**

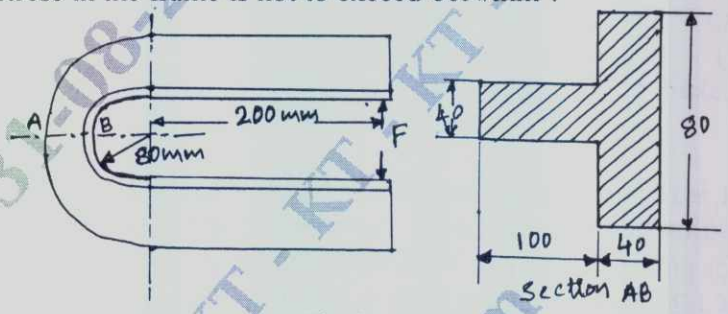

Fig.Q.1(a)

b. The horizontal section of a crane hook is an isosceles triangle of 90mm deep, the inner width being 80mm. The hook carries a load of 40kN and the inner radius of curvature is 80mm. The load line is nearer to the inner surface of the hook by 20mm than the center of curvature at critical section. Find the extreme intensities of stresses at critical section. **(08 Marks)**

2 a. Calculate the maximum tangential stress induced when a 150mm diameter solid steel shaft is pressed fitted with a 300mm outer diameter cast iron hub having 200mm length. The maximum diametral interference due to the selected fit is 0.06mm. Take E = 100GPa for cast iron and E = 200Gpa for steel. The Poisson's ratio for both cast iron and steel is 0.3 and the coefficient of friction is 0.12. Also find the axial force required to press the hub on the shaft and the torque that may be transmitted with this fit. **(08 Marks)**

b. A cast iron cylindrical pipe of outside diameter 300mm and inside diameter 200mm is subjected to an internal pressure of 20N/mm^2 and external fluid pressure of 5N/mm^2. Determine the tangential and radial stresses at the inner, middle and outer surface. Sketch the tangential and radial stress distribution across the thickness. **(08 Marks)**

3 a. A compressor requiring 90kW is to run at 250rpm. The drive is by V-belts from an electric motor running at 750rpm. The diameter of the pulley on the compressor shaft is 1m, while the center distance between the pulleys is limited to 1.75m. The belt speed should not exceed 1600 m/min. Determine the number of V-belts required to transmit the power if each belt has a cross sectional area of 375mm^2 and density of 1Mg/m^3 and has an allowable stress of 2.5N/mm^2. The groove angle of the pulley is 35° and the coefficient of friction between the belt and pulley is 0.25. **(08 Marks)**

b. A 20mm 8 × 19 steel wire rope is used with a hoisting drum of 1m diameter to lift a load of 20kN. The depth of the mine is 0.8km and the acceleration is 3m/s^2. Determine the number of ropes required using a factor of safety 5. Neglect the tackle weight. **(08 Marks)**

4 a. A machine weighing 500kN is mounted on 10 springs in order to protect the building from vibrations. The section of the spring wire is rectangle with side ratio 1.6. Each spring has four active turns and the spring index is 6. Determine:
   i) Section of the spring so that longer side is parallel to the spring axis.
   ii) Deflection of the spring when the machine is stationary.
   iii) Shear stress induced if the shorter side is parallel to the spring axis.
   The allowable shear stress is 300MPa and the rigidity modulus is 82.7GPa. **(08 Marks)**

b. A cantilever spring has 6 graduated leaves and 2 extra full length leaves. The effective length of the spring is 750mm and the leaves are 50mm wide. The spring is to sustain a load of 2.5kN and the corresponding deflection at the end of the spring is 60mm. Determine:
   i) Thickness of the leaves
   ii) Load shared by full length leaves
   iii) Load shared by graduated leaves
   iv) Stress in full length leaves
   v) Stress in graduated leaves.
   Take E = 206.8GPa. **(08 Marks)**

5 It is required to transmit 15kW power from a shaft running at 1200rpm to a parallel shaft with speed reduction of 3. The center distance of shafts is to be 300mm. The material used for pinion is steel (σ_d = 200MPa) and for gear is cast iron (σ_d = 140MPa). The service factor is 1.25 and the tooth profile is 20° full depth involute. Design the spur gear and check the design for dynamic and wear load. **(16 Marks)**

6 A pair of straight tooth right angled bevel gears transmitting 7.5kW at 300rpm of pinion. The pressure angle is 20°. The pitch diameters of pinion and gear at their larger ends are 150mm and 200mm respectively. The face width of the gears is 40mm. Determine the components of the resultant gear tooth force and draw free body diagram of forces acting on the pinion and gear tooth. **(16 Marks)**

7 A single thread steel worm rotates at 1800rpm, meshing with a 24 tooth phosphor bronze worm gear (σ_0 = 103.5MPa) transmitting 3kW to the output shaft. The worm pitch diameter is 75mm and tangential module of the gear is 6mm. The normal pressure angle is $14\frac{1}{2}^\circ$. The gear face width is 50mm.
   i) Find the mesh efficiency
   ii) Transmitted gear forces
   iii) Is the mesh sufficient to handle the loading
   iv) Find the power lost by friction. **(16 Marks)**

8 a. Derive the expression for torque transmitted by disc clutch for i) Uniform pressure condition and ii) Uniform wear condition. **(08 Marks)**

b. A differential band brake shown in Fig.Q.8(b), the brake is to sustain a torque of 425N-m. The coefficient of friction between the band and the drum is 0.153. Determine:

i) Necessary operating force F

ii) Width and thickness of the steel band if the safe tensile stress in the band is $55N/mm^2$.

iii) Section of the brake lever if the allowable bending stress is $60N/mm^2$. Take the depth of lever as twice the width. **(08 Marks)**

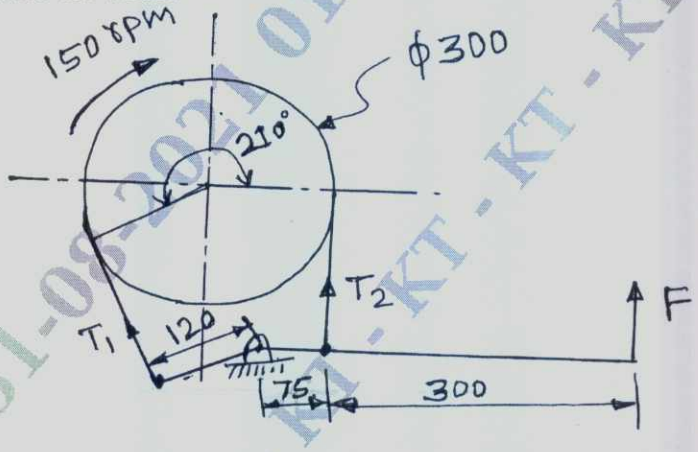

Fig.Q.8(b)

9 a. Derive Petroff's equation for a lightly loaded bearing. **(08 Marks)**

b. A 75mm long full journal bearing of diameter 75mm supports a radial load of 12kN at shaft speed of 1800rpm. Assume ratio of diameter to diametral clearance as 1000. The viscosity of oil is $0.01N/m^2s$ at the operating temperature. Determine:

i) Sommerfeld number.

ii) Coefficient of friction based on McKee's equation.

iii) Amount of heat generated. **(08 Marks)**

10 a. A single row deep ball groove ball bearing has a specific dynamic capacity of 45kN. The actual radial load F_r = 8.5kN. The speed of rotation is 1750rpm. What is the life in; i) in hours ii) cycles of operations iii) what is the average life? **(08 Marks)**

b. Select suitable single row radial ball bearings to carry a radial load of 1.5kN and a thrust load of 1.2kN at 900rpm. The bearing is to be used 7 hours per day and average service life of 8 years is desired. Consider the design load for bearing during selection with speed factor, life factor, thrust factor and application factor. **(08 Marks)**

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CBCS SCHEME

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Sixth Semester B.E. Degree Examination, July/August 2021
Metal Forming

Time: 3 hrs. Max. Marks: 80

Note: *Answer any FIVE full questions.*

1 a. What is metal forming? Give the classification of metal forming processes. **(04 Marks)**
b. State the advantages and limitations of metal forming process. **(06 Marks)**
c. Briefly explain the concept of true-stress-true strain. **(06 Marks)**

2 a. Briefly explain Tresca and Von-Mises yield criteria. **(08 Marks)**
b. Define biaxial stress and Triaxial stress clearly. **(04 Marks)**
c. Differentiate between Hot and Cold working processes. **(04 Marks)**

3 a. Explain the deformation by slip and Twinning mechanisms with neat sketches. **(08 Marks)**
b. Explain the effect of following parameter in metal forming process i) Temperature ii) Lubrication. **(04 Marks)**
c. Briefly explain deformation zone geometry is metal forming process. **(04 Marks)**

4 a. What is forging? With neat sketch explain open die and closed die forging processes. **(06 Marks)**
b. With neat sketch, explain forging die design parameters. **(06 Marks)**
c. Briefly explain various forging defects. **(04 Marks)**

5 a. With neat sketches, explain different types of rolling mills. **(08 Marks)**
b. Explain the effects of front and back tension in rolling process. **(04 Marks)**
c. If the maximum reduction is rolling of slab is form 25mm to 20mm. Calculate the value of coefficient of friction. Take the roll diameter as 500mm. Also find the length of projection of arc of contact. **(04 Marks)**

6 a. With neat sketches, explain any two methods of tube drawing processes. **(08 Marks)**
b. Briefly, explain Redundant work and estimation of redundant work in drawing. **(08 Marks)**

7 a. What is extrusion? With neat sketches explain direct and indirect extension processes. **(08 Marks)**
b. Briefly explain the variables in extrusion process. **(08 Marks)**

8 a. With neat sketches, explain progressive and compound die. **(08 Marks)**
b. With neat sketches, explain Rubber forming and stretch forming processes. **(08 Marks)**

9 a. State the advantages, disadvantages and application of HERF. **(06 Marks)**
b. With neat sketch explain Electrohydralic forming process. **(05 Marks)**
c. With neat sketch, explain Electromagnetic forming process. **(05 Marks)**

10 a. Briefly explain the steps involved in powder metallurgy process with a flow chart. **(06 Marks)**
b. With neat sketch explain Atomization process. **(05 Marks)**
c. State the advantages and limitation of powder metallurgy process. **(05 Marks)**

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CBCS SCHEME

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15ME664

Sixth Semester B.E. Degree Examination, July/August 2021
Total Quality Management

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions.

1	a.	Define quality. Mention any four dimensions of quality with meaning.	(06 Marks)
	b.	Explain six basic approaches of TQM.	(06 Marks)
	c.	Mention any four benefits of ISO registration.	(04 Marks)
2	a.	Explain TWM framework with a neat diagram.	(08 Marks)
	b.	In brief explain any four obstacles of TQM.	(04 Marks)
	c.	Explain about ISO 9001 requirements.	(04 Marks)
3	a.	Define leadership. Explain any six characteristics of quality leaders.	(08 Marks)
	b.	Mention any four duties of quality council.	(04 Marks)
	c.	Briefly explain about decision making.	(04 Marks)
4	a.	Explain any eight points of Deming philosophy.	(08 Marks)
	b.	Mention and explain the seven steps to strategic planning.	(08 Marks)
5	a.	Explain the six factors of customer perception of quality.	(06 Marks)
	b.	Define motivation. Explain five steps of Maslow's hierarchy of needs.	(06 Marks)
	c.	Mention eight benefits of employee involvement.	(04 Marks)
6	a.	Explain any six information collecting tools of a feedback.	(06 Marks)
	b.	Define team and briefly explain the four types of team.	(06 Marks)
	c.	Explain in brief about performance appraisal.	(04 Marks)
7	a.	Explain the four primary improvement strategies.	(08 Marks)
	b.	What is meant by KAIZEN? Explain.	(04 Marks)
	c.	Define measures of central tendency and measures of dispersion.	(04 Marks)
8	a.	Define cause and effect diagram. Explain with general example.	(06 Marks)
	b.	Explain the seven phases of problem solving methods in brief with respect to PDSA cycle.	(06 Marks)
	c.	With a graph, explain the Scatter diagram.	(04 Marks)
9	a.	Define benchmarking. Explain benchmarking concept with a diagram.	(08 Marks)
	b.	Explain the terms E-Government and E-Commerce.	(04 Marks)
	c.	Define reliability and explain.	(04 Marks)
10	a.	Explain the benefits of quality function deployment.	(08 Marks)
	b.	Compare quality by design with sequential engineering on time line with a neat diagram.	(08 Marks)

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