CBCS SCHEME

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15ME61

Sixth Semester B.E. Degree Examination, Dec.2018/Jan.2019
Finite Element Analysis

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Define Finite Element Method, explain basic steps involved in FEM **(10 Marks)**

b. A rectangular bar is subjected to an axial load "p" as shown in Fig.Q1(b), determine the expression for P.E functional and hence determine value of the potential energy (PE) for the following data : E = 200GPa, P= 3kN, L = 100mm, b = width = 20mm, t = 10mm. **(06 Marks)**

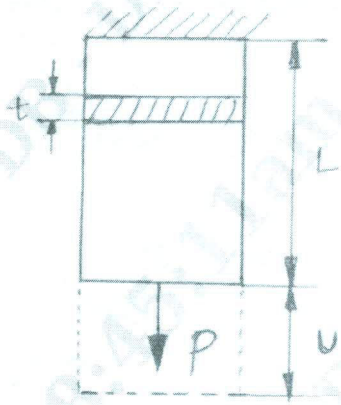

Fig.Q1(b)

OR

2 a. Find the maximum deflection using Galerkin's method, Fig.Q2(a). **(10 Marks)**

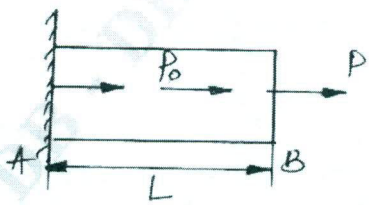

Fig.Q2(a)

b. Explain Simplex, Complex and Multiplex Elements with examples. **(06 Marks)**

Module-2

3 a. Derive the shape function of a bar element in Global Co-Ordinate System. **(10 Marks)**

b. Use two-point Gaussian quadrature formula to evaluate the integral $I = \int_0^3 (2^{\xi} - \xi)\, d\xi$. **(06 Marks)**

OR

4 a. The structured member shown in Fig.Q4(a) consists of two bars. An axial load of P = 200kN is loaded as shown. Determine the following :

i) Element Stiffness Matrix
ii) Global Stiffness Matrix
iii) Global Load Vector
iv) Modal Displacement. **(06 Marks)**

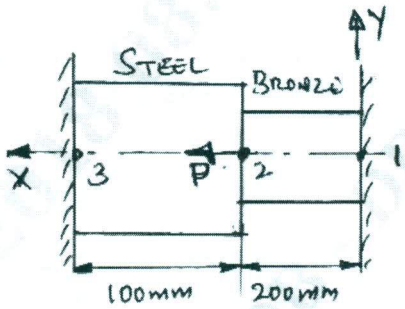

Fig.Q4(a)

b. A 4 bar truss element as shown in Fig.Q4(b), determine i) Nodal displacement ii) stress in each element, area of truss element = 100mm; E = 2×10^5N/mm^2. **(10 Marks)**

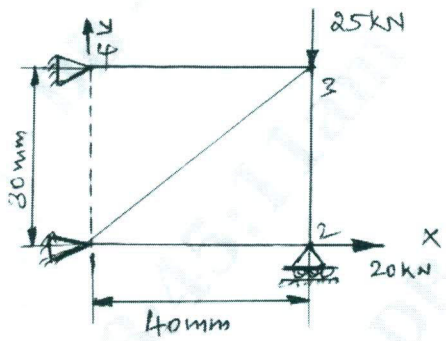

Fig.Q4(b)

Module-3

5 a. Derive Hermite shape functions of a beam element and show the variation of the shape function over the element. **(10 Marks)**

b. Derive the potential energy functional (π) for beam. **(06 Marks)**

OR

6 a. A cantilever beam subjected to point load of 250 kN as shown in Fig.Q6(a). Determine the deflection at the free end and the support reactions. Take E = 200GPa, I = 4×10^6 mm^4. **(10 Marks)**

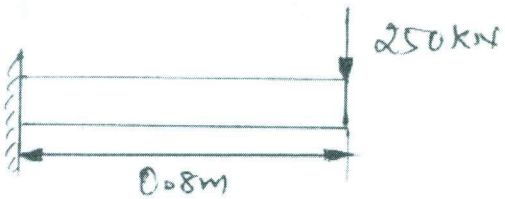

Fig.Q6(a)

b. Derive the stiffness matrix for a circular shaft subjected to pure torsion. **(06 Marks)**

Module-4

7 a. Derive the one-dimensional formulation of fin (Heat transfer thin fins). **(10 Marks)**

b. Determine the temperature distribution in the rectangular fin as shown in Fig.Q7(b). Assume steady and only conduction process. Take heat generated inside the fin as $400w/m^3$. **(06 Marks)**

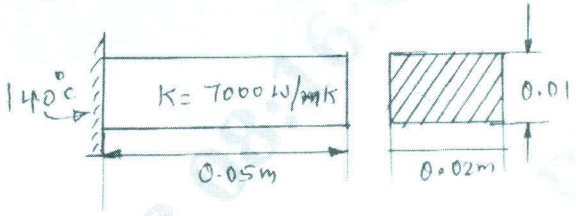

Fig.Q7(b)

OR

8 a. For the smooth pipe shown in Fig.Q8(a) with uniform cross–section of $1m^2$, determine the flow velocities at the centre and right end, knowing the velocity at the left is $V_x = 2m/sec$. **(10 Marks)**

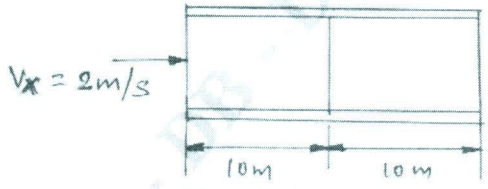

Fig.Q8(a)

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

Module-5

9 a. Derive the stiffness matrix of axisymmetric bodies with triangular elements. **(10 Marks)**

b. For the element of an axisymetric body rotating with a constant angular velocity w = 1000 rev/min as shown in Fig.9(b). Determine the body force vector. Include the weight of the material, where the specific density is 7850 kg/m^3. **(06 Marks)**

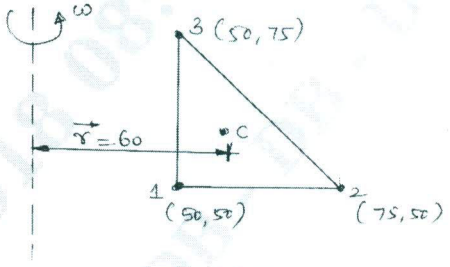

Fig.Q9(b)

OR

10 a. Derive the consistent mass matrix for truss element. **(06 Marks)**

b. Determine the natural frequency of longitutational vibration of the bar shown in Fig.Q10(b). Take E = 200GPa ; $\rho = 7840\ kg/m^3$; $A = 240mm^2$. **(10 Marks)**

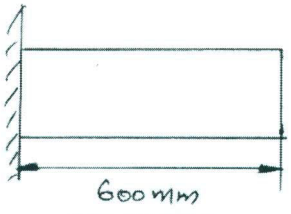

Fig.Q10(b)

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15ME62

Sixth Semester B.E. Degree Examination, Dec.2018/Jan.2019
Computer Integrated Manufacturing

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Define Automation. Explain the different types of automation in brief with suitable examples. **(10 Marks)**

b. Explain the following mathematical models :
(i) Manufacturing Lead Time
(ii) Production Rate
(iii) Availability **(06 Marks)**

OR

2 a. Enumerate the objectives of Automated flow lines. **(08 Marks)**

b. With a neat sketch explain Rotary configuration. **(08 Marks)**

Module-2

3 a. Explain in brief the major functions of Graphics package in mechanized environment. **(07 Marks)**

b. A square with an edge length of 10 units is located on the origin with one of the edge at an angle of 30° with positive x-axis. Calculate the new position of the square if it is rotated about z-axis by an angle 30° in clockwise direction. **(09 Marks)**

OR

4 a. With a neat sketch explain Retrieval CAPP system. **(08 Marks)**

b. Explain the structure of MRP system with the help of block diagram. **(08 Marks)**

Module-3

5 a. What are the benefits of Flexible Manufacturing System? **(08 Marks)**

b. List out the advantages of Group Technology. **(08 Marks)**

OR

6 a. Explain in brief the different types of AS/RS systems. **(06 Marks)**

b. The following data refers to the precedence relationship and element times for a New product.

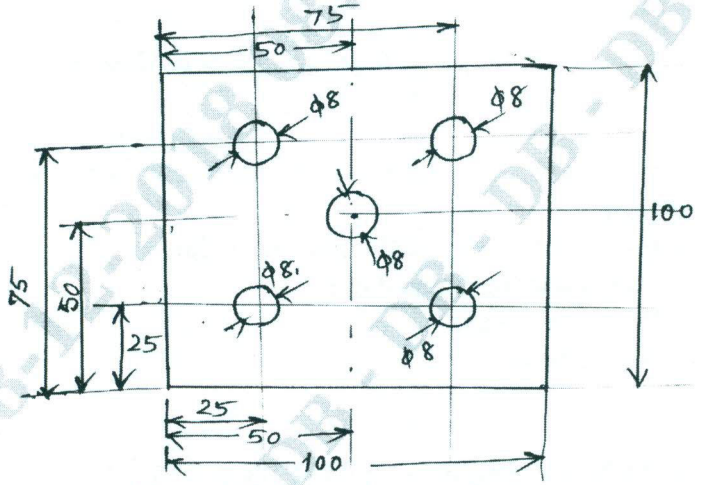
Element No.	1	2	3	4	5	6	7	8	9	10	11	12
T_c (min)	0.2	0.4	0.7	0.1	0.3	0.11	0.32	0.6	0.27	0.38	0.5	0.12
Precedence	-	-	1	1, 2	2	3	3	3, 4	6, 7, 8	5, 8	9, 10	11

Using Largest candidate rule method,
(i) Construct the precedence diagram.
(ii) If the ideal cycle time is 1.0 min find the number of work stations required.
(iii) Balance delay and Balancy efficiency. **(10 Marks)**

Module-4

7 a. With the help of block diagram explain the elements of CNC system and highlight its advantages. **(10 Marks)**

b. Write a part program for the following :
- figure (drawing) - Peck drilling operation – Take drill dia 8 mm. [Refer Fig.Q7(b)]



Note : All dimensions are in mm

Fig.Q7(b) **(06 Marks)**

OR

8 a. Define Industrial Robot. Explain the different configurations of a robot with neat sketches. **(10 Marks)**

b. Explain the following Terminology related to robot.
(i) Accuracy (ii) Resolution (iii) Repeatability. **(06 Marks)**

Module-5

9 a. What is additive manufacturing? Explain the different steps involved in preparing a component. **(08 Marks)**

b. Explain the different powder Bed Fusion technique developed. **(08 Marks)**

OR

10 a. Explain in brief the various components of Industry 4.0. **(10 Marks)**

b. Write a short note on Cloud computing. **(06 Marks)**

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CBCS SCHEME

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15ME63

Sixth Semester B.E. Degree Examination, Dec.2018/Jan.2019
Heat Transfer

Time: 3 hrs. Max. Marks: 80

Note: 1. ***Answer 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 three modes of heat transfer with their basic laws. **(06 Marks)**

b. The inner wall of the furnace is made of fire brick of thickness 115 mm and the outer wall is made of red brick of thickness 230 mm. The temperature of the inside furnace is 685°C and the temperature of outside surface of red brick is 121°C under steady state condition to reduce the heat loss a layer of Magnesia insulation of thickness 50 mm is added on the outer surface of red brick after steady state condition is reached. The various temperature are measured as flame side of furnace 712°C junction between the fire brick and red brick is 655°C, junction between the red brick and Magnesia is 490°C outer surface Magnesia temperature is 77°C. Calculate the heat loss in first and second cases and find the percentage of heat loss reduction. Assume thermal conductivity of Magnesia is 0.085 W/m°C. **(10 Marks)**

OR

2 a. State the assumptions and derive general 3-dimensional heat conduction equation in Cartesian co-ordinates. **(08 Marks)**

b. A hollow sphere is made up of steel having thermal conductivity of 45 W/m°C. It is heated by means of a coil of resistance 100 Ω which carries a current of 5 amps. The coil is located inside a hallow space at the centre. The outer surface area of sphere is 0.2 m^2 and its mass 32 kg assuming density of the sphere material to be 8 gm/cc. Calculate the temperature difference between the inner and outer surface. **(08 Marks)**

Module-2

3 a. Derive an expression for the temperature distribution and heat flow for a pinfin, when the tip of the fin is insulated. **(08 Marks)**

b. A thin rod of copper K = 100 W/m°C, 12.5 mm in diameter spans between two parallel plates 150 mm apart. Air flows over the rod providing a heat transfer co-efficient of 50 W/m^2°C. The surface temperature of the plate exceeds the air by 40°C. Determine (i) The excess temperature at the centre of the rod over that of air and (ii) Heat lost from the rod in watts. **(08 Marks)**

OR

4 a. Show that the temperature distribution under lumped analysis is given by,

$$\frac{T - T_\infty}{T_i - T_\infty} = e^{-BiFo}$$

Where T_i = Initial temperature

T_∞ = Ambient temperature **(08 Marks)**

b. A 15 mm diameter mild steel sphere (K = 42 W/m°C) is exposed to coding air flow at 20°C resulting in the convective co-efficient h = 120 W/m^2°C. Determine the following:

(i) Time required to cool the sphere from 550°C to 90°C.
(ii) Instantaneous heat transfer rate for 2 mins after start of cooling.
(iii) Total energy transferred from the sphere during first 2 mins.

Take for mild steel S = 7850 kg/m^3, C_P = 475 J/kg°C, α = 0.045 m^2/hr **(08 Marks)**

Module-3

5 a. Explain three types of boundary conditions applied in Finite difference representations. **(09 Marks)**

b. Consider steady-state heat conduction in a square region of side 2b, in which energy is generated at a constant rate of g w/m^3. The boundary conditions for the problem are shown in Fig. Q5 (b). Write the finite difference equations for nodes 1, 3 and 5 in this Fig. Q5 (b) **(07 Marks)**

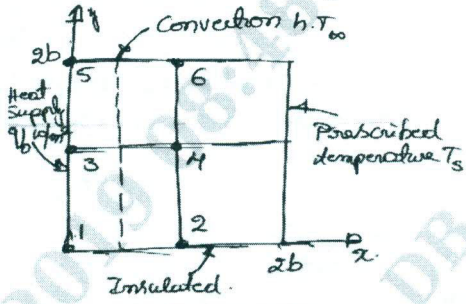

Fig. Q5 (b)

OR

6 a. State and explain : (i) Kirchoff's law (ii) Plank's law (iii) Wein's displacement law (iv) Lambert's cosine law. **(08 Marks)**

b. Two large parallel plots with emissivity 0.5 each are maintained at different temperatures and are exchanging heat only by radiation. Two equally large radiation shields with surface emissivity 0.05 are introduced in parallel to the plates. Find the percentage reduction in net radiative heat transfer. **(08 Marks)**

Module-4

7 a. With a diagram, explain velocity boundary layer and thermal boundary layer. **(08 Marks)**

b. Lubricating oil at a temperature of 60°C enters a 1 cm diameter tube with a velocity 3.5 m/s. The tube surface is maintained at 30°C. Calculate the tube length required to cool the oil to 45°C. Assume that the oil has the following average properties for the temperature range of this problem S = 865 kg/m^3, K = 0.14 W/m°K, C_P = 1.78 kJ/kgK and $\gamma = 9 \times 10^{-6}$ m^2/s. **(08 Marks)**

OR

8 a. Explain the significance of, (i) Reynold's number (ii) Prandtl number (iii) Nusselt number (iv) Stanton number. **(08 Marks)**

b. Calculate the convection heat loss from a radiator 0.5 m wide and 1 m high maintained at a temperature of 84°C in a room at 20°C. Treat the radiator as a vertical plate. **(08 Marks)**

Module-5

9 a. With assumptions, determine LMTD for counter flow heat exchanger. **(08 Marks)**

b. A parallel flow heat exchanger uses 1500 kg/hr of cold water entering at 25°C to cool 600 kg/hr of hot water entering at 70°C. The exit temperature on the hot side is required to be 50°C. Neglecting the effects of fouling make calculations for the area of heat exchanger. It may be assumed that the individual heat transform co-efficient on both sides are 1600 W/m^{2}K. Use LMTD and NTU approaches. **(08 Marks)**

OR

10 a. With a neat sketch, explain the different regimes of pool boiling. **(08 Marks)**

b. A vertical square plate 300m × 300m is exposed to steam at atmospheric pressure. The plate temperature is 98°C. Calculate the heat transfer and the mass of steam condensed per hour. **(08 Marks)**

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CBCS SCHEME

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15ME64

Sixth Semester B.E. Degree Examination, Dec.2018/Jan.2019
Design of Machine Elements – II

Time: 3 hrs. Max. Marks: 80

Note: 1. Answer any FIVE full questions, choosing one full question from each module.
2. Use of hand book is permitted.

Module-1

1 a. List the assumptions made in obtaining stress equation in curved beam. **(06 Marks)**

b. Compute the combined stresses at the inner and outer fiber in the critical cross-section of a crane hook which is required to lift loads upto 25 kN. The hook has trapezoidal cross section with the parallel sides 60mm and 30mm. The distance between them being 90mm. The inner radius of hook is 100 mm. The load line is nearer to the inner surface of the hook by 25 mm than the centre of curvature at the critical section. What will be the stresses at inner and outer fiber, if the beam is treated as straight beam for given load? **(10 Marks)**

OR

2 a. A cast iron cylindrical pipe of outside diameter 300mm and inside diameter 200mm is subjected to an internal pressure of 20 MPa and external pressure of 5 MPa. Determine the tangential and radial stresses at inner, middle and outer surface. Also sketch the stresses distribution across the thickness. **(08 Marks)**

b. A 440 mm outer diameter, 250mm inner diameter and 300mm long steel hub is to be shrink on to a 250mm diameter steel shaft. If the torque is to be transmitted is 300 kNm and $\mu = 0.18$, determine the amount of interference required. **(08 Marks)**

Module-2

3 a. A belt is required to transmit 18.5 kW from a pulley of 1.2m diameter running at 250 rpm to another pulley which run at 500 rpm. The distance between the centres of pulley is 2.7m. The following data refers to open belt drive $\mu = 0.25$. Safe working stress for leather is 1.75 MPa. Thickness of belt 10 mm. Determine the width and length of belt taking centrifugal tension into account. Also find the initial tension in belt and speed at which this can be transmitted. **(08 Marks)**

b. A V-belt is to transmit 20 kW from a 250 mm pitch diameter operating at 1500 rpm to a 900 mm diameter flat pulley. The centre distance between input and output shaft 1 m. The groove angle is 40° and $\mu = 0.2$ for both pulleys and shears combination. The cross section of belt is 38mm wide at the top and 19mm at bottom by 25mm deep. Each belt weighs 11 kN/m^3 and allowable tension per belt is 1000 N. How many belts are required? **(08 Marks)**

OR

4 a. A loaded narrow gauge car weighs 18 kN and moving at a velocity of 80 m/min is brought to rest by a buffer spring of two helical springs. In bringing the car to rest the spring undergoes a compression of 200mm. The allowable shear stress is 0.3 GPa and spring index is 8. Solve for the dimensions of spring. Take G = 84 GPa. **(08 Marks)**

b. A semi-elliptical leaf spring is used for the suspension of the rear axle of a truck. It consists of 2 extra full length leaves and IS graduated leaves with a band of 100 mm. The centre to centre distance between spring eyes is 1.1 m. All leaves are pre-stressed to 400 MPa. E = 200 GPa. The max. force on spring is 75 kN. Take total depth to width ratio as 2. Determine (i) Cross section of leaf (ii) Initial nip (iii) Load on band. **(08 Marks)**

Module-3

5 Design a pair of spur gear 20° involute to transmit 30 kW of power at 600 rpm of pinion. Number on teeth on pinion is 15, transmission ratio is 5:1. Material of the pinion is cast steel (σ = 137.34 MPa) and that of gear is high grade cast iron (σ = 103 MPa.). **(16 Marks)**

OR

6 a. Derive an equation for formative number of teeth on bevel gear. **(06 Marks)**

b. Determine the module for a pair of helical gear to transmit 15 kW of power at 4000 rpm of pinion with i = 5:1. Pinion is made of 0.4% carbon steel untreated (σ = 69.6 MPa) and gear is made of cast iron (σ = 31 MPa). Helix angle is 20°. Number of gear teeth on. Pinion is 24. (Gear system 20° FDI). **(10 Marks)**

Module-4

7 Design worm drive to transmit a power of 2 kW at 1000 rpm, i = 20:1 and centre distance is 200 mm. **(16 Marks)**

OR

8 a. Design a multi-plate clutch to transmit 25 kW at 300 rpm. The plates have friction surfaces of steel and phosphorous bronze run on oil. Design clutch for 25% over load. **(08 Marks)**

b. A simple band brake is required to transmit a torque of 100 kg-m. The brake drum diameter is 400 mm, μ = 0.25. Find the effort required to obtain braking in clock-wise direction. Design the band and the lever. Take θ = 270°. [Refer Fig.Q8(b)] **(08 Marks)**

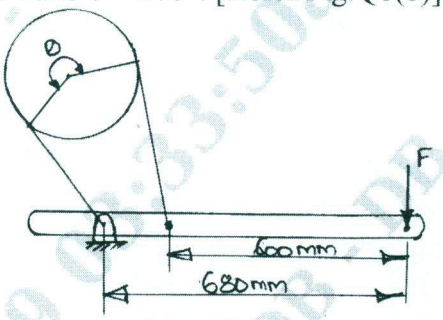

Fig.Q8(b)

Module-5

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

b. A lightly loaded journal bearing has a load of 1 kN. The oil used is SAE60 and mean effective temperature of operation is 40°C. The journal has a diameter of 50 mm and the bearing has a diameter of 50.5mm. The speed of journal is 15000 rpm. The L/d ratio is limited to 1.2. Determine CoF and power loss in friction. **(10 Marks)**

OR

10 a. Explain the principle of Hydro Dynamic lubrication. **(06 Marks)**

b. A spindle of a wood-working machine runs at 1000 rpm. It is mounted on two single-row ball bearings. One of which is required to carry radial load of 2250 N and thrust load of 1900 N. The machine runs 8 hrs/day. Assuming a life of 4 years a spindle diameter equal to 30 mm. Select a suitable bearing. **(10 Marks)**

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CBCS SCHEME

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15ME655

Sixth Semester B.E. Degree Examination, Dec.2018/Jan.2019
Automobile Engineering

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. State the materials used for cylinder block, Piston, connecting rod and crank shaft. **(04 Marks)**

b. What are the methods of swirl generation in C.I engines? Explain briefly. **(06 Marks)**

c. Explain with neat sketch the forced circulation type water cooling system. **(06 Marks)**

OR

2 a. Explain with neat sketch the dry linear and wet liner. **(06 Marks)**

b. Explain the working of pressurized (force feed) lubrication system with sketch. **(06 Marks)**

c. Write short notes on:
   i) HCCI engine
   ii) Electric car. **(04 Marks)**

Module-2

3 a. What is the function of clutch? Explain with neat sketch the working of single plate clutch. **(06 Marks)**

b. What is final drive? Explain with neat sketch the working of differential. **(06 Marks)**

c. Name the forces and torques experienced by rear axle and state (Name) the rear axle drive arrangements. **(04 Marks)**

OR

4 a. State the function of brakes, and give the detailed classification of brakes. **(04 Marks)**

b. With a neat sketch, explain the working of hydraulic brake system. **(06 Marks)**

c. Write short notes on :
   i) Disc brakes
   ii) Air brake
   iii) Antilock brake system. **(06 Marks)**

Module-3

5 a. Define the terms: Camber, Kingpin inclination, Castor, Toe – in. **(04 Marks)**

b. Explain with neat sketch the Recirculating ball type steering gear box. **(06 Marks)**

c. Draw the layout of an air suspension system and state the advantages of air suspension. **(06 Marks)**

OR

6 a. State the requriments of an ignition system. **(04 Marks)**

b. With a neat circuit diagram, explain the working of Battery ignition system. **(06 Marks)**

c. Explain with neat sketch the rotating magnet type magneto ignition system. **(06 Marks)**

Module-4

7 a. State the advantages of supercharging and explain with neat sketch the centrifugal supercharger working. **(08 Marks)**

b. What is turbocharger lag? Explain with neat sketch the operation of turbocharger. **(08 Marks)**

OR

8 a. Explain briefly :
   i) Octane Number and Cetane Number
   ii) Detonation
   iii) Carburettor
   iv) Multi point Fuel injection (MPFI) **(08 Marks)**

   b. Name the alternate fuels for automobiles, and explain the Air-fuel mixture requirements for S.I engines operation under steady state. **(08 Marks)**

Module-5

9 a. Name the different pollutants emitted from automobile engines, and explain exhaust Gas Recirculation. **(08 Marks)**

   b. Explain with neat sketch the positive crankcase ventilation. **(08 Marks)**

OR

10 a. With a neat sketch explain the operation of Air injection system for treating the exhaust gas. **(08 Marks)**

   b. Write a note on the following :
   i) Photo chemical smog
   ii) Catalytic converter
   iii) Bharat stage Norms
   iv) Motor vehicle Act. **(08 Marks)**

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CBCS SCHEME

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15ME664

Sixth Semester B.E. Degree Examination, Dec.2018/Jan.2019
Total Quality Management

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Define TQM. Explain six basic concepts of TQM. **(08 Marks)**
b. List and explain dimensions of Quality. **(08 Marks)**

OR

2 a. Explain the contributions of Quality Gurus. **(06 Marks)**
b. Sketch the TQM Frame work. **(04 Marks)**
c. Write short note on Benefits of ISO Registration. **(06 Marks)**

Module-2

3 a. Explain the characteristics of Quality Leaders. **(08 Marks)**
b. Define Ethics. List any six leadership concepts. **(08 Marks)**

OR

4 List Deming's 14 points and explain any one. **(16 Marks)**

Module-3

5 a. With a neat sketch, explain Kano – Model. **(08 Marks)**
b. State and explain Elements of customers service. **(08 Marks)**

OR

6 a. Explain Maslow's hierarchy of needs. **(08 Marks)**
b. Define : Motivation , Performance , Reward , Recognition , Empowerment , Gainsharing , Teams , Union. **(08 Marks)**

Module-4

7 a. Write short note on Six – Sigma. **(08 Marks)**
b. Explain i) PDSA cycle with continuous process improvement ii) KAIZEN. **(08 Marks)**

OR

8 a. Explain Control charts for variables and attributes. **(08 Marks)**
b. Explain : i) Pareto diagram ii) Cause and effect diagram. **(08 Marks)**

Module-5

9 a. With a neat sketch, explain Benchmarking Concept. **(08 Marks)**
b. Define QFD. With a neat sketch, explain 4 phases of QFD process. **(08 Marks)**

OR

10 a. Sketch the concept of Quality by Design and list the benefits of Quality by design. **(08 Marks)**
b. Define FMEA. List the stages of FMEA. **(08 Marks)**

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CBCS SCHEME

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15ME61

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

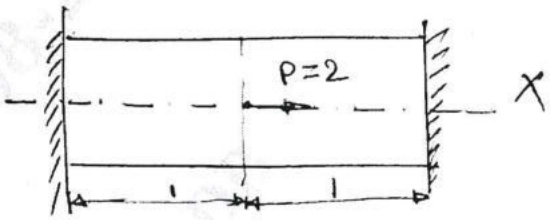
Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions.

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.

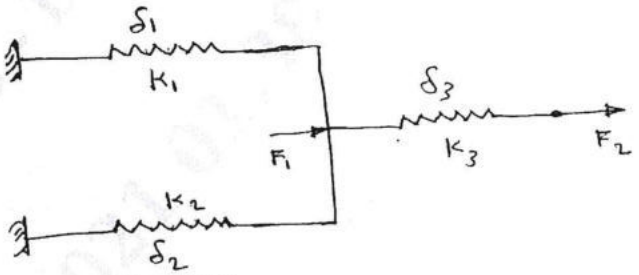
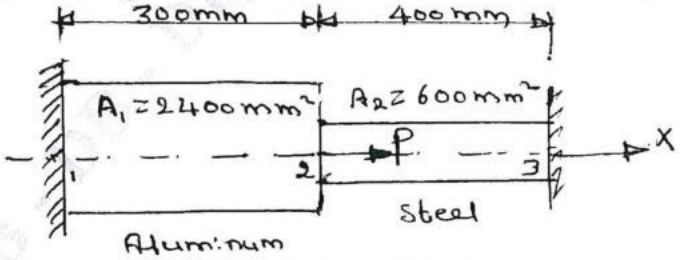


Fig.Q2(b) **(08 Marks)**

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 × 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

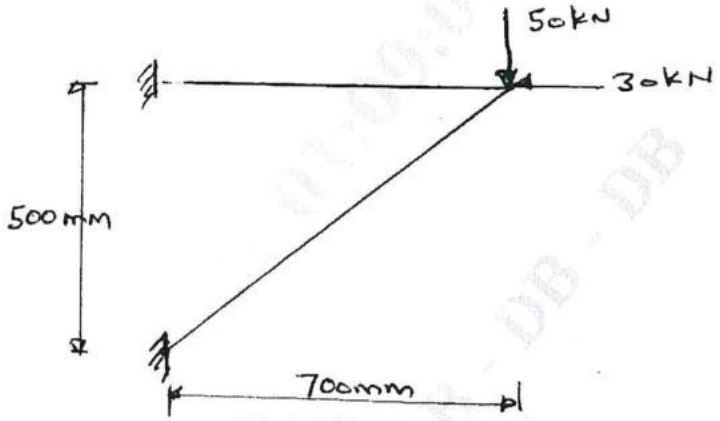


Fig.Q4(b) **(10 Marks)**

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.

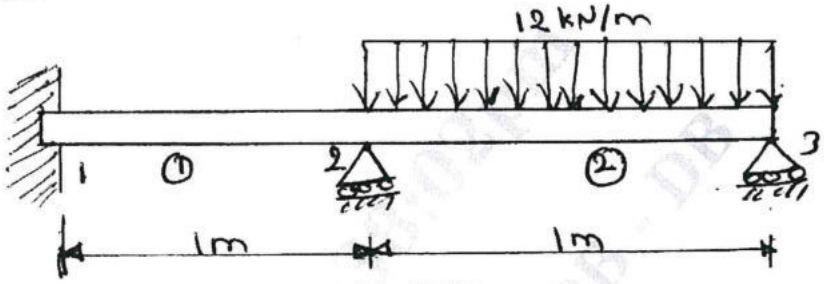


Fig.Q5(b) **(10 Marks)**

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.

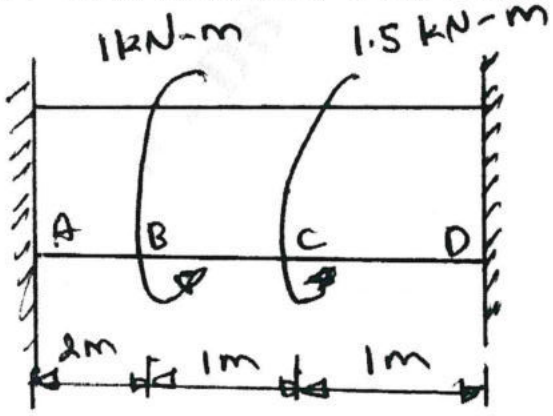
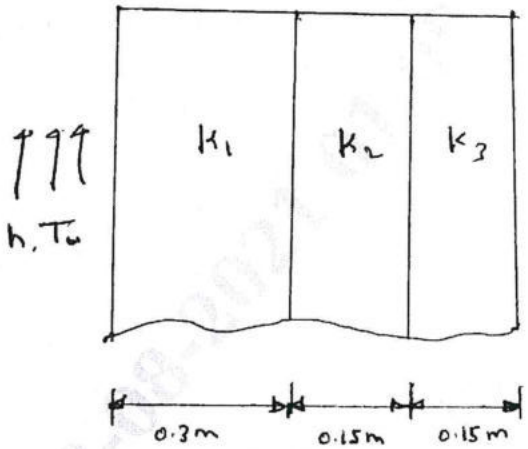


Fig.Q6(b) **(10 Marks)**

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.

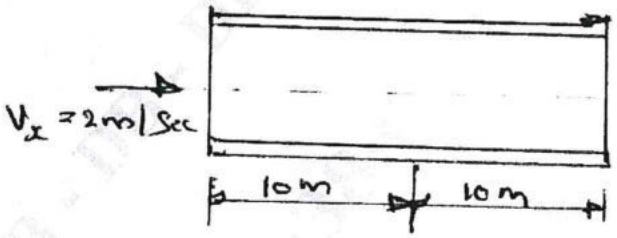


Fig.Q8(b) **(10 Marks)**

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, $\gamma = 0.3$.

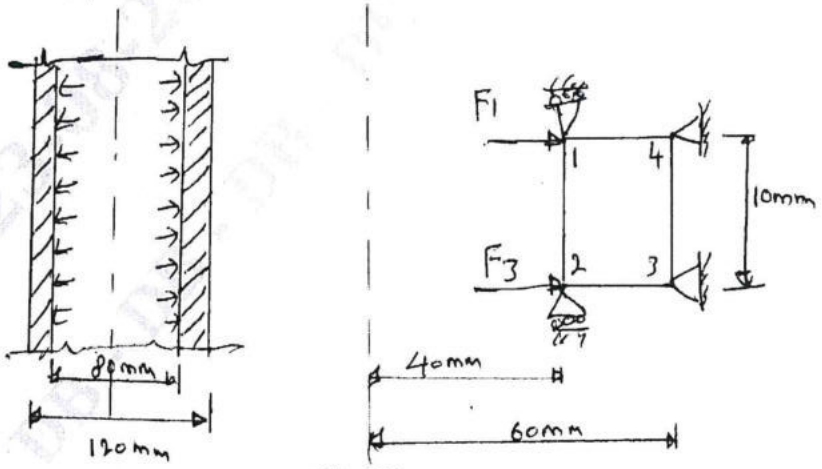


Fig.Q9 **(16 Marks)**

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.

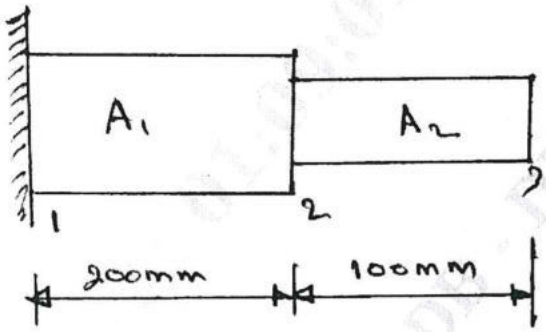


Fig.Q10 **(16 Marks)**

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CBCS SCHEME

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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 $\gamma = 2.076 \times 10^{-5}\ m^2/sec$, $P_r = 0.697$,

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

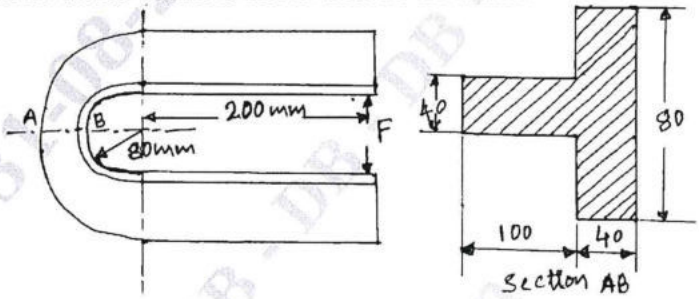

Fig.Q.1(a)

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)**

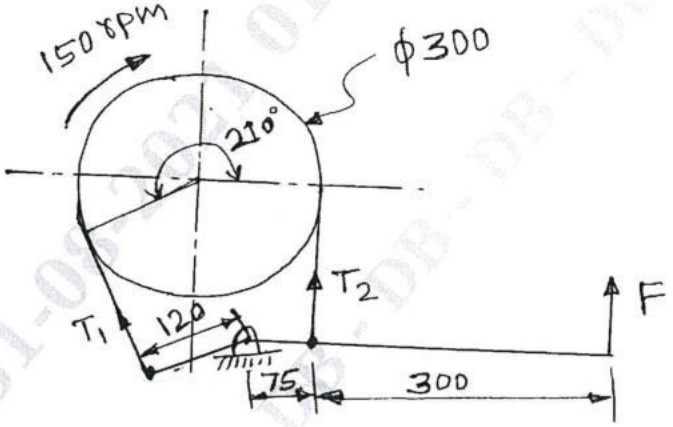

Fig.Q.8(b)

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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