QUESTION BANK

B.Tech –III Year –II Semester

DEPARTMENT OF MECHANICAL ENGINEERING

MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

(An Autonomous Institution – UGC, Govt.of India)

Recognizes under 2(f) and 12(B) of UGC ACT 1956

(Affiliated to JNTUH, Hyderabad, Approved by AICTE –Accredited by NBA & NAAC-"A" Grade-ISO 9001:2015 Certified)

MACHINE DESIGN -II

UNIT-I

1 (A) What are rolling contact bearings? Discuss their advantages over sliding contact bearings.

(B)A ball bearing subjected to a radial load of 5KN is expected to have a life of 8000 hours at 1450 rpm with a reliability of 99 percent. Calculate the dynamic load capacity of the bearing so that it can be selected from manufactures catalogue based on a reliability of 90 percent.

2 (A) List the important physical characteristics of a good bearing material.

(B)The main bearing of a steam engine is 100 mm and 175 mm long. The bearing supports a load of 28 KN at 250 rpm. If the ratio of diametral clearance to the diameter is 0.001 and absolute viscosity of the lubricating oil is 0.015 kg/m-s. Find: i) the coefficient of friction and ii) heat generated at the bearing due to friction.

3 A 100 mm long and 60 mm diameter journal bearing supports a load of 2500 N at 600 rpm. If the room temperature is 20ºC, what should be the viscosity of oil to limit the bearing surface temperature to 60ºC? Diametral clearance = 0.06 mm. Energy dissipation coefficient based on the projected area of the bearing = 210 W/m2ºc

4 A 250×250 mm bearing carries a load of 108 KN. The bearing rotates at 1500 rpm. The clearance ratio is 670. For full journal bearing the power lost in friction is 14.36 KW. Find the viscosity of the oil.

5 (A) Formulate the heat generated and dissipated in a journal bearing.

(B)A shaft is mounted on two roller bearings, which are 350 mm apart. The shaft carries a bevel gear at the middle. At a shaft speed of 900 rpm; the gear forces are: radial load = 10 kN, and thrust load = 3.5 kN. Determine the rated dynamic capacity of the bearing, for a desired life of 10,000 hours. The service factor is 1.5, thrust factor is 0.67 and radial load factor is 0.67.

UNIT-II

1 The following data is given for the piston of a four stroke diesel engine. Cylinder bore=100 mm, Material of piston rings=grey cast iron, Allowable tensile stress=90 MPa, Allowable radial pressure on the cylinder wall=0.035MPa, Thickness of the piston head=16 mm, Number of piston rings=4 Calculate (i) Radial width of piston rings (ii) Axial thickness of the piston rings (iii) Gap between the free ends of the piston ring

before assembly (iv) Gap between the free ends of the piston ring after assembly (v) Width of the top land (vi) Width of ring grooves (vii) Thickness of piston barrel and (viii) Thickness of barrel at top end.

2 The following data is given for the cap and bolts of the big end of the connecting rod. Engine speed=1500rpm, length of the connecting rod =320mm, length of stroke=140mm, mass of reciprocating parts=1.75kg, length of crank pin=54mm, diameter of the crank pin=38mm, permissible tensile stress for the bolts=120MPa, permissible bending stress for cap=120MPa. Calculate the nominal diameter of the bolts and thickness of the cap for the big end.

3 (A) Explain the various types of cylinder liners.
(B)Discuss the design of piston for an internal combustion engine.

4 A connecting rod is to be designed for a high speed, four stroke IC engine. The following data are available. Piston diameter=88mm; Mass of reciprocating parts=1.6kg; Length of the connecting rod (centre to centre)=300mm; Stroke=125mm; RPM=2200 (when developing 50kw); Possible over speed=3000rpm; compression ration = 6.8:1; Probable explosion pressure=3.5MPa. Design and draw fully dimensioned drawing of the connecting rod.

5 The following data is given for a connecting rod:Engine speed =1500 rpm, Length of connecting rod=320 mm, Length of stroke=140 mm, Density of the material=7830 Kg/m^3, Thickness of web flanges= 6 mm, The cross section of the connecting rod is I section. Upper and bottom flange dimensions are = 4mm, Web dimensions are = 3mm, Calculate the whipping stress in connecting rod.

6 (A) Explain different materials used for piston

(B)The following data is given for the piston of a four stroke diesel engine. The following data is given for the piston of a four stroke diesel engine. Cylinder bore = 120 mm,Maximum gas pressure = 6 MPa ,Allowable bearing pressure for skirt = 0.45 MPa, Ratio of side thrust on liner to maximum gas load on piston=0.1 Width of top land =20 mm, Width of ring grooves = 3 mm ,Total number of piston rings = 4 ,Axial thickness of piston rings = 3.5 mm Calculate (i)length of skirt (ii) length of piston

UNIT-III

1 A V belt drive is required for a 15 KW, 1440 rpm electric motor, which drives a centrifugal pump running at 360 rpm for a service of 24 hours per day. From space considerations, the center distance should be approximately1m. Determine

(i) Belt specifications
(ii) Number of belts
(iii) Correct center distance and
(iv) Pulley diameters

2 A100 mm wide and 10 mm thick belt transmits 5 KW between two parallel shafts. The distance between the shaft centers is 1.5 m and the diameter of the smaller pulley is 440 mm. The driving and driven shafts rotate at 60 rpm and 150 rpm respectively. Find the stress in the belt, if the two pulleys are connected by i) open belt ii) a cross belt. The coefficient of friction is 0.22

3 It is required to select a v-belt drive to connect a 20 KW, 1440 rpm motor to compressor running at 480 rpm for 15 hours per day. Space is available for a center distance approximately 1.2m. Determine

i) The specifications of the belt ii) Diameter of the motor and compressor pulleys
iii)The correct center distance and the number of belts

4 A rope drive is required to transmit 750 kW from a pulley of 1 m diameter running at 450 r.p.m. The safe pull in each rope is 2250 N and the mass of the rope is 1 kg / m length. The angle of lap and the groove angle are 150° and 45° respectively. Find the number of ropes required for the drive if the coefficient of friction between the rope and the pulley is 0.3.

5 Recommend a flat belt drive for driving a centrifugal pump with 10 KW motor operating continuously at 1750 rpm. The pump speed should be 875 rpm and the centre distance may be from 750 mm to 1000 mm. The preferable distance may be 900 mm.

UNIT-IV

1 A spur gear made of bronze drives a mild steel pinion with angular velocity ratio of 3.5. The pressure angle is 14.5 degrees. It transmits 5 KW at 1800 rpm of pinion. Considering only strength, design the smallest diameter gears and find also necessary face width. The number of teeth should not be less than15 teeth on either gear. The elastic strength of bronze may be taken 84 MPa and of steel as105 MPa. Lewis form factor for 14.5 degrees pressure angle may be taken as $y = 0.124 - \frac{0.684}{T}$

Where T=No. of teeth.

2 A pair of helical gears with 30^0 helix angle is used to transmit 15 KW at10000 rpm of the pinion. The velocity ratio is 4:1. Both gears are to be made of hardened steel of static strength 100MPa. The gears are 200stub and the pinion is to have 24 teeth. The face width may be taken as14 times the module. Find the module and face width from the stand point of strength and check the gears for wear.

3 (A) How the gears are classified and what are the various terms used in spur gear technology?

(B) Discuss the design procedure of spur gears.

4 (A) A parallel helical gear 300 mm in diameter has 200 involute full depth teeth and helix angle is 300. It transmits a torque of 4500 N-m. Find the tangential, radial and axial loads acting on the teeth. Indicate them graphically.

(B)A pair of straight teeth spur gears is to transmit 20 kW when the pinion rotates at 300 rpm. The velocity ratio is 1:3. The allowable static stresses for the pinion and gear materials are 120 MPa and 100 MPa respectively. The pinion has 15 teeth and its face width is 14 times the module. Determine i) Module ii) face width iii) pitch circle diameters of both the pinion and gear from the stand point of strength only, taking into consideration the effect of the dynamic loading. The tooth form factor can be taken as $y=0.154 \frac{0.912}{no. of\ teeth}$ and the velocity factor $Cv = \frac{3}{3+v}$ where v is expressed in m/sec

5 A pair of parallel helical gears consists of a 20 teeth pinion meshing with a 100 teeth gear. The pinion rotates at 720 rpm. The normal pressure angle is 200, while the helix angle is 25^0, the face width is 40 mm and the normal module is 4 mm. the pinion as well as gear is made of steel 40C8 (Sut = 600 N/mm2) and heat treated to a surface hardness of 300 BHN. The service factor and the factor of safety are 1.5 and 2 respectively. Assume that the velocity factor accounts for the dynamic load and calculate the power transmitting capacity of gears.

UNIT-V

1 A double threaded power screw, used for lifting the load, has a nominal diameter of 25 mm and a pitch of 6mm. The coefficient of friction of screw threads is 0.1. Neglecting collar friction, calculate. i) efficiency of the screw with the square threads ii) efficiency with Acme threads

2 The nominal diameter of a triple threaded square screw is 50 mm, while the pitch is 8 mm. It is used with a collar having an outer diameter of 100 mm and inner diameter as 65 mm. The coefficient of friction at the thread surface as well as at the collar surface can be taken as 0.15. The screw is used to raise a load of 15 kN. Using the uniform wear theory for collar friction, calculate: (i) torque required to raise the load; (ii) torque required to lower the load; and (iii) the force required to raise the load, if applied at a radius of 500 mm.

3 (A)Distinguish between the Square and ACME threads.

(B)The nominal diameter of a triple threaded square is 50mm, while the pitch is 8mm. It is used with a collar having outer diameter of 100mm and inner diameter 65mm. The coefficient of friction at the thread surface as well as collar surface can be taken as 0.15. The screw is used to raise a load of 15kN. Using uniform wear theory for collar friction, Calculate i) torque required to raise the load ii) torque required to lowering the load.

4 The lead screw of lathe has ACME threads of 50mm outside diameter and 8 mm pitch. The screw must exert an axial pressure of 2500N in order to drive the tool carriage. The thrust is carried on a collar 110mm outside diameter and 55mm inside diameter and lead screw rotates at 30r.p.m. Derive i)the power required to drive the screw, ii) the efficiency of the lead screw. Assume coefficient of friction of 0.15 for screw and 0.12 for collar.

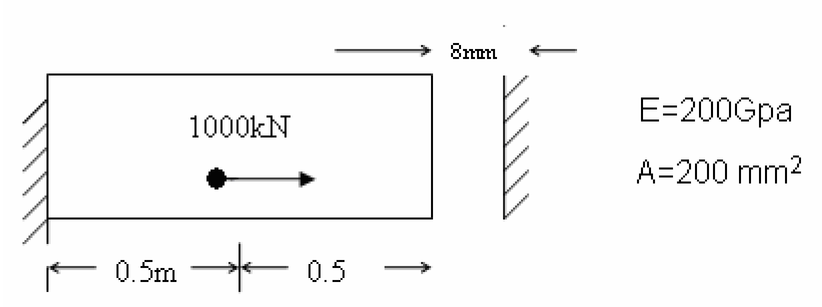
5 (A) Differentiate between differential screw and compound screw.

(B)A vertical two start square threaded screw of a 100 mm diameter and 20mm pitch supports a vertical load of 18kN. The axial thrust on the screw is taken by a collar bearing of 250mm outside diameter and 100 mm inside diameter. Find the force required at the end of a lever of 400 mm long in order to lift and lower the load. The coefficient of friction for the vertical screw and net is 0.15 and that for collar bearing is 0.20.

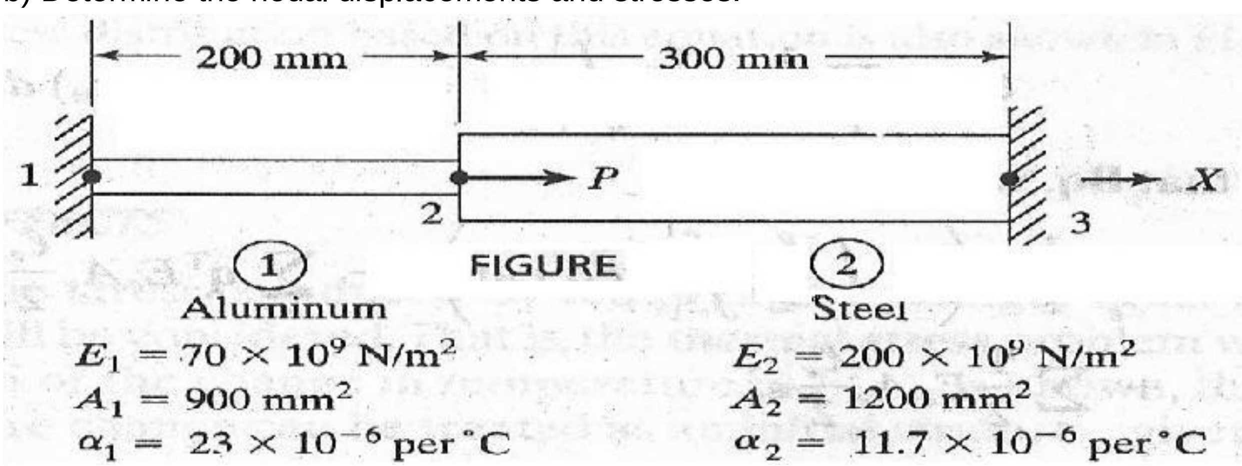
FINITE ELEMENT METHOD

UNIT I

1. Differentiate between plane stress and plane strain problems with suitable examples and derive the elasticity matrix for both the conditions.
2. Explain the general procedure of finite element analysis step by step with suitable examples.
3. Draw the shape functions of a quadratic element.
4. a) Derive the stiffness matrix of axial bar element from the first principles.
   b) Calculate the model displacement and forces for the stepped bar with the stiffness values are 12 k N/m and 8K/M and a load of 6 KN is subjected at the end of the stepped bar and the other end of the bar is fixed.
5. Calculate the displacements, strains, stresses and reaction of a bar subjected to a tensile load is shown in figure.



6. An axial load P=300X103N is applied at 200 C to the rod as shown in Figure below. The
   temperature is the raised to 600 C .
   a) Assemble the K and F matrices.
   b) Determine the nodal displacements and stresses.



7. Determine the nodal displacement, Element stresses for axially loaded bar as shown in the fig. below

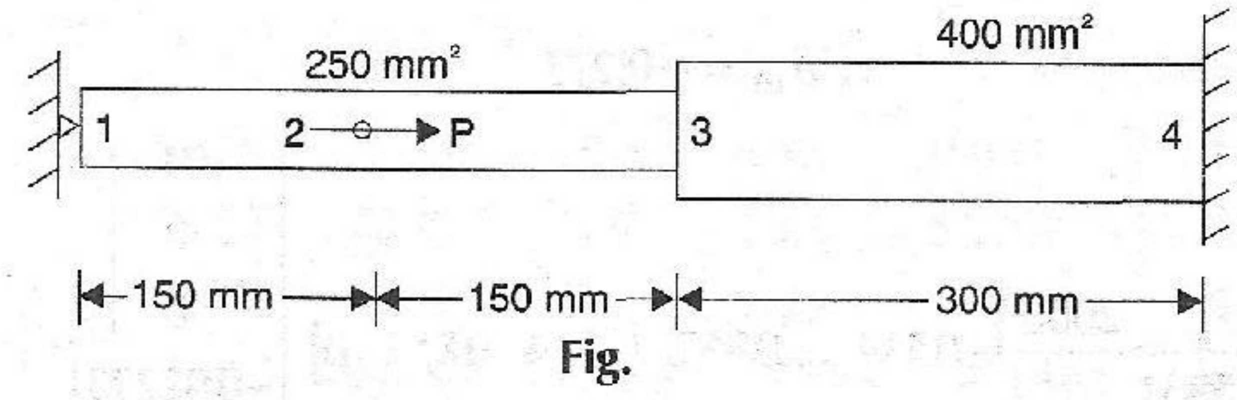
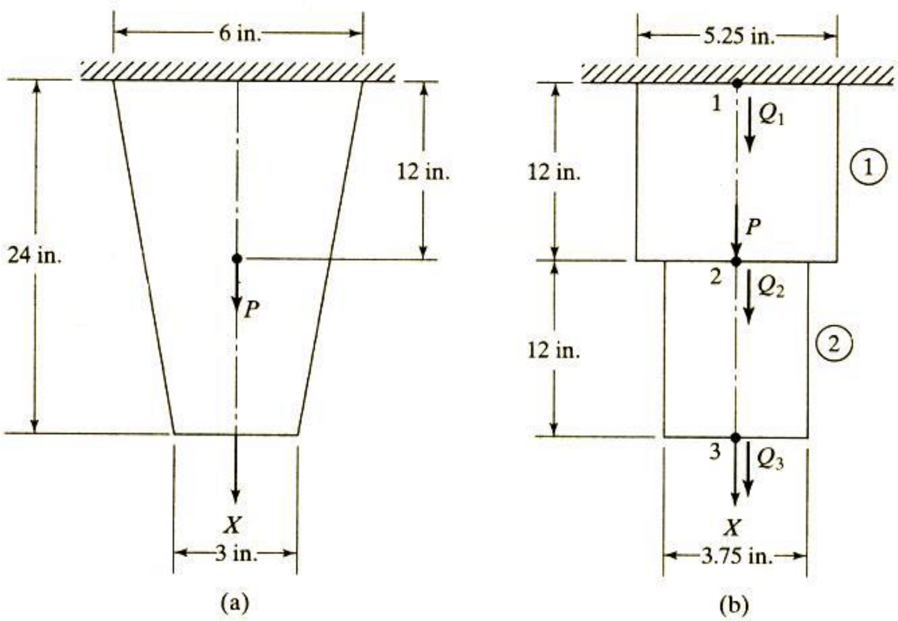


Fig.

8. Consider the thin (steel) plate in Fig. The plate has a uniform thickness t =10 mm, Young's modulus E = 100Gpa, and weight density=78500N/m3 . In addition to its self-weight, the plate is subjected to a point load P = 60N at its midpoint.
   a) Write down expressions for the element stiffness matrices and element body force vectors
   b) Evaluate the stresses in each element .Determine the reaction force at the support. consider 1in=1cm for SI UNITS



UNIT II

1. For the two-bar truss shown in Figure below, determine the nodal displacements, element stresses and support reactions. A force of P=1000kN is applied at node-1. Assume E=210GPa and A=600mm2 for each element.

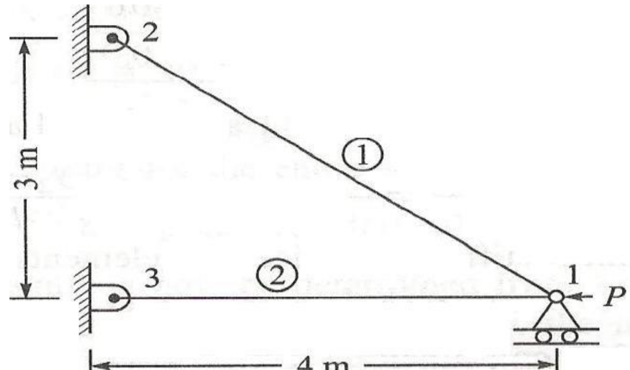


Figure two-bar truss.

2. For the truss shown in fig.2 determine the a) displacements and b)stresses in the bars .

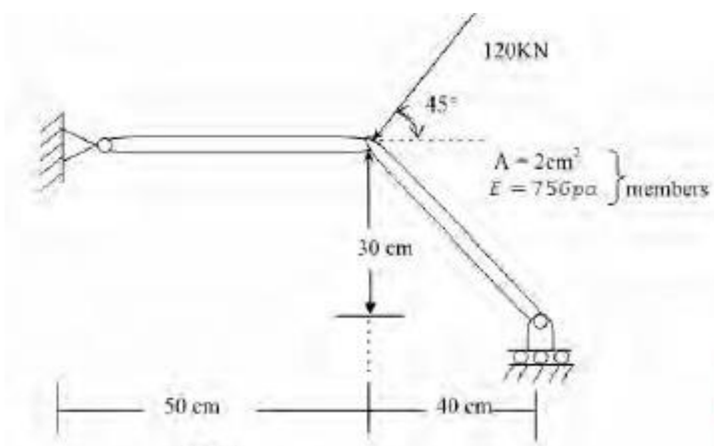
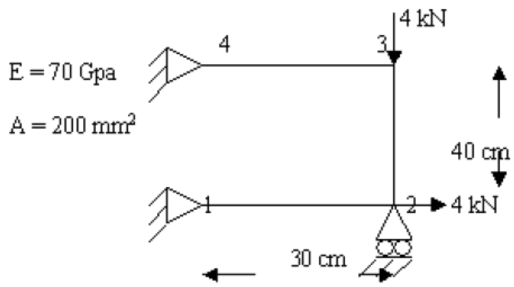


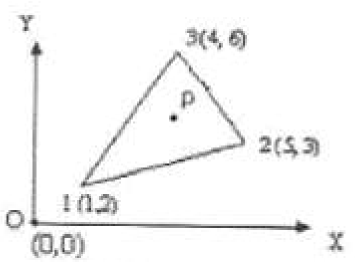
Fig. 2

3. For the truss structure shown in figure with indicated load, calculate displacements and stress in each element.

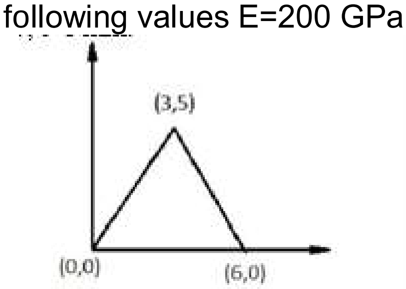


4. a) State the properties and applications of CST

b)The nodal coordinates of the triangular element shown in figure at the interior point P.the x coordinate is 3.3 and the shape function at node 1 is N1is 0.3.determine the shape functions at nodes 2 and 3 also find the 'y' coordinate of P



5. Evaluate the element stiffness matrix for the triangular element shown under plane strain condition. Assume the following values E=200 GPa, μ=0.25, t=1 mm



6. a)Distinguish between local, natural and global coordinates.

b) For the pin jointed configuration shown in Fig.5, determine;

i) displacement ii) element stress 3

given $ά=10x10^{-6}$ per 0C $ΔT=50^0$

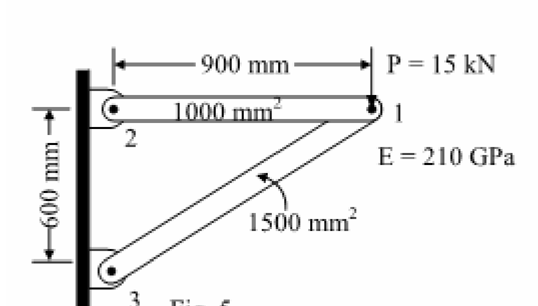
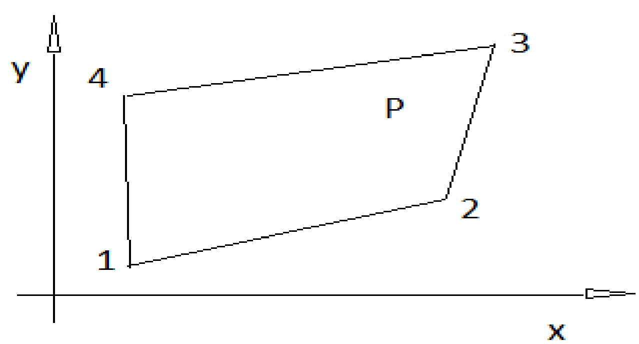


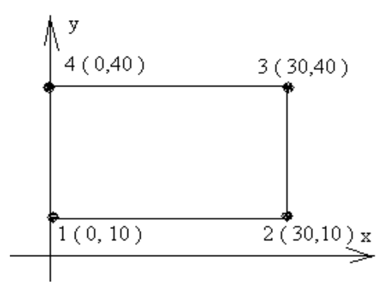
Fig. 5

UNIT III

1. For the Isoparametric quadrilateral element shown in fig , determine the local co-ordinates of the point P whose Cartesian co=ordinates as(6,4)

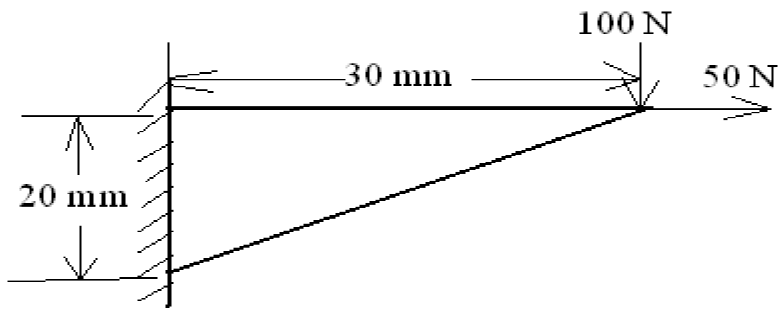


2. For the element shown in the figure, assemble Jacobian matrix and strain displacement matrix



3. What do you mean by a aximetric problem? If the displacement functions
   $u = 3x^2 + 60\,xy - 20\,y^2$
   $\upsilon = -4\,x^2 - 20xy + 5\,y^2$ then find the strains E_x, E_y and γ_{xy} at a point P (-1, 1).

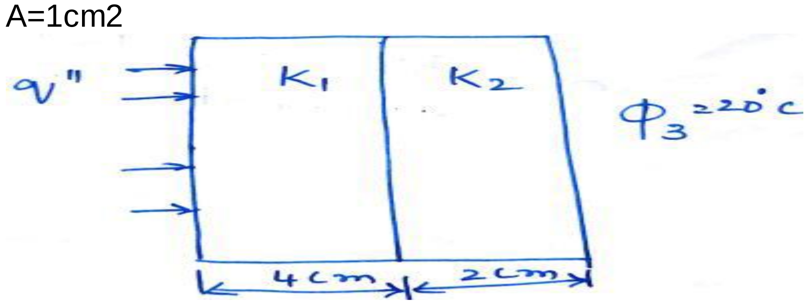
4. Derive the strain displacement matrix for triangular element.
5. a).Explain Iso-parametric, sub-parametric and super-parametric elements
   b) Advantages of iso-parametric elements
   c) Write short notes on Gaussian quadrature integration technique



UNIT IV

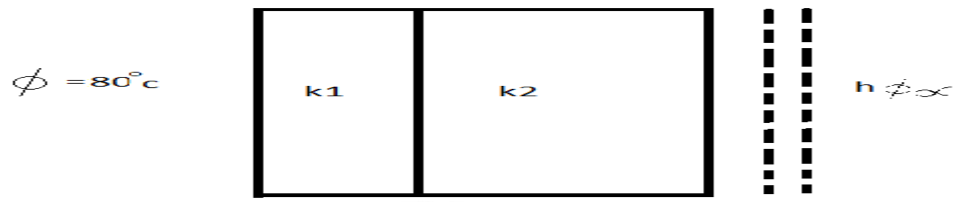
1. Determine the temperature at the nodal interfaces for the two layered wall shown in fig. the left face is supplied with heat flux of q11=5w/cm2 and right face in main fained at 200C.

Qu=5w/cm2
K1=0.2W/cm0C
K2=0.06W/cm0C
A=1cm2

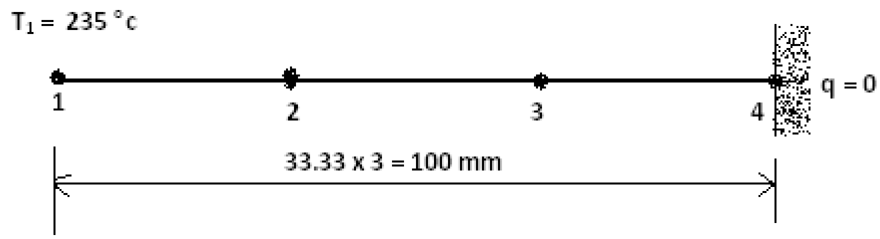


2. Determine the nodal temparatures and rate of heat transfer through a composite wall shown in fig. Thermal conductivities K1=45w/m0C and K2=0.5w/m 0C. Convective heat transfer co-efficient h=20w/m2 0C, Temparature of left face of wall =800C and Ambient

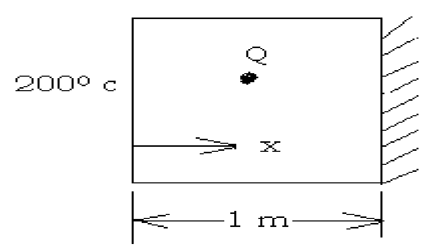
temperature Øα=250C. Assume the area normal to the direction of heat flow =1cm2.Use linear elements



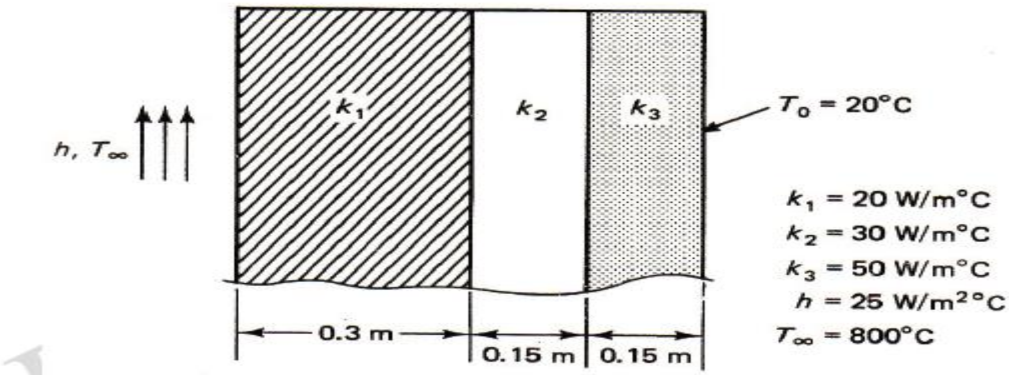
3. A metallic fin with thermal conductivity K=360W/m0c, 1mm thick and100mm long extends from a plane wall whose temperature is 2350c. Determine the distribution and amount of heat transferred from the fin to air at 200c with h= 9W/m20c take width of the fin is 1000 mm. Assume tip is insulted.



4. The plane wall shown in fig. The thermal conductivity K = 25W/m0c and there is a uniform generation of heat in the wall of Q = 400W/m3. Determine the temperature distribution at five nodes (include two sides of the walls) in equal distances through the wall thickness.

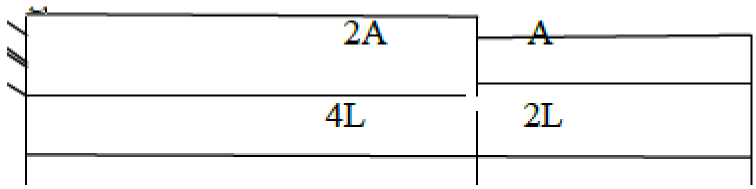


5. A composite wall consists of three materials as shown in Fig.5. The outer temperature isT_0 = 20^{0}C. Convection heat transfer takes place on the inner surface of the wall with T∞= 800^{0}C and h= 25 W/m^2 ^{o}C. Determine the temperature distribution in the wall.

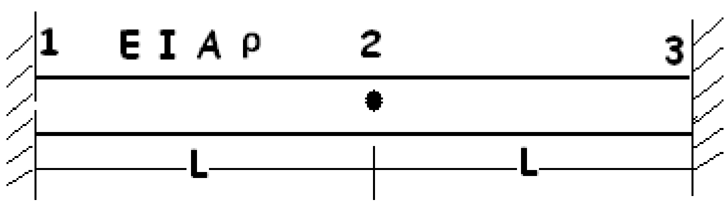


UNIT V

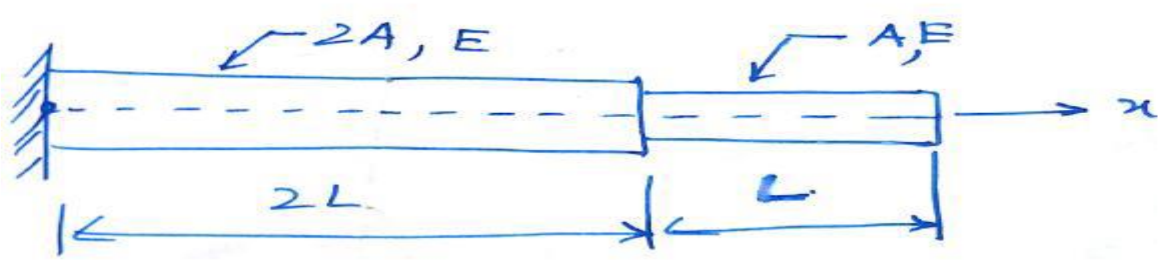
1. Evaluate natural frequencies for the stepped bar shown in fig b)corresponding eigenvectors and mode shapes. take E=200Gpa and density 7500 Kg/m3 .Take A=600mm2and LENGTH L=300mm



2. Determine the Natural frequency of the beam shown in the figure.

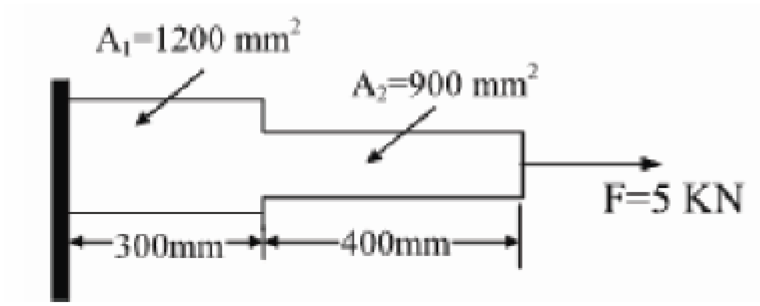


3. Derive the eigen value eigen vector and mode shapes of the given stepped bar element. When L=length; A=Area of cross-section E=Modules of electivity and Ᵽ=Density of the material

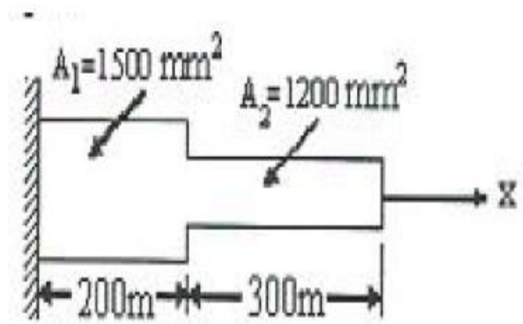


4. Determine the mass matrix for truss element with an example.
Consider axial vibration of the Aluminium bar shown in Figure below,
a. Develop the global stiffness and

b. Determine the nodal displacements and stresses using elimination approach and with help of linear and quadratic shape function concept. Assume Young's Modulus E = 70Gpa.



5. Determine the natural frequencies and mode shapes of a stepped bar shown in figure below using the E=300GPa and density is 7800 Kg/m3.



6. Answer the following:

(a) Numerical Integration and importance of Gussian quadrature.

(b) Analysis of a uniform shaft subjected to torsion.

(c) When and where 3D analysis is preferred over 2D analysis? Sketch the elements and discuss

HEAT TRANSFER

UNIT - I

1. Define basic laws of heat transfer?
2. Discuss basic laws of 3 modes of heat transfer?
3. Derive general conduction equation in Cartesian coordinates?
4. Derive conduction equation in cylindrical coordinates?
5. Derive conduction equation in spherical coordinate systems?
6. What are the applications of heat transfer?
7. What are the different forms of heat transfer?
8. Describe different types of boundary conditions apply to heat conduction problem?
9. Derive one dimensional steady state conduction equation in case of slab
10. Explain the following (i) Logmean area (ii)geometric mean area
11. What is critical thickness of insulation explain
12. Derive the conduction in onedimensional case for a cylinder
13. What are the assumptions for heat transfer analysis in case of fins
14. Derive the expression for heat transfer in fins in case of (i)Rectangular
15. plate fin of uniform crossection (ii)insulated end
16. How do you estimate error in temperature measurment
17. Explain briefly (i)Fin effectiveness (ii) Fin effeciency
18. Explain the heat transfer analysis in composite wall
19. Derive expression for critical thickness of insulation for a cylinder.
20. Define lump
21. Explain the concept of lumped annalysys
22. Derive the expression for heat transfer under transient mode
23. Define Biot number and Fourier number
24. Explain how biot number help in transient conduction problem
25. What are heisleir charts
26. Enumerate steps for solving long cylinders using heislier charts
27. Enumerate steps for heat transfer analysis in slabs using heislier charts.

PROBLEMS – I

1. An insulated pipe of 50 mm outside diameter (€=0.8)is laid in a room at 30 0C.If the surface temperatures is 250 0 C and the convective heat transfer coefficient is 10 W/m2K.Calculate the heat loss per unit length of pipe. Sheets of brass and steel each 1 cm thickness are in contact. The outer surface of brass is at 100 0C. And that of steel is at 0 0 C. and K d/Ks = 2.

2. Determine Interface temperature of sheets A steam pipe of (€=0.9)of 0.4 m diameter has a surface temperature of 500 0C.and is located in a large room at 25 0 C where h =25 W/m.2K. Find (i) Combined heat transfer coefficient (ii)The rate of heat loss per unit length If the combustion chamber wall is made up of Firebrick (k=0.145 W/mK, € =0.85)and is 1.45 cm thickness, Compute the overall heat transfer coefficient for the following data.

3. Gas temperature 800 0C Wall temperature on gas side =798^{0}C Film conductance on gas side40w/m^{2}K Film conductance on coolant side 10 W/m^{2}K Radiation shape factor between wall and gas =1

4. The convective heat transfer coefficient h=2.512(ΔT)0.25 W/m^2 K.A hot plate of A=0.2 m^2 at 59^{0}C losses heat to a room temperature 20^{0}C.Find the fraction of heat lost by natural convection when heat is transferred from the plate steadily at the rate of 100 W.

5. The roof of an electrically heated home is 6 m long, 8 m wide, and 0.25 m thick, and is made of a flat layer of concrete whose thermal conductivity k is 0.8 W/m°C. The temperatures of the inner and the outer surfaces of the roof one night are measured to be 15°C and 4°C, respectively, for a period of 10 hours. Determine (a) the rate of heat loss through the roof that night and (b) the cost of that heat loss to the home owner if the cost of electricity is $ 0.08 Kj/kWh.

6. Consider a person standing in a breezy room at 20°C. Determine the total rate of heat transfer from this person if the exposed surface area and the average outer surface temperature of the person are 1.6 m2 and 29°C, respectively, and the convection heat transfer coefficient is 6 W/m^2°C

7. A Hollow heat cylinder with r_1=30 mm and r_2=50 mm , k=15W/mK is heated on the inner surface at a rate of 105 W/m^2 and dissipates heat by conduction from the outer surface to a fluid at 100^{0}Cwith h=400 W/m^{2}K.Find the temperature inside and outside surfaces of the cylinder. and also find rate of heat transfer through the wall A tube 2 cm. O.D maintained at uniform temperature of Ti is covered with insulation (k=0.20 W/mK) to reduce heat loss to the ambient air T∞ with ha=15W/m2K.Find i) the critical thickness rc of insulation (ii)the ratio of heat loss from the tube with insulation to that with out insulation, (a) if the thickness of insulation is equal to rc Three 10cm dia rods A,B and C protrude from a steam bath at 100 0C to a length of 25cm into an atmosphere at 20 0C. The temperature at the other end are Ta=26.760C, Tb=320C and Tc=36.930C.

8. Find the thermal conductivities of the rod A, B and C, if h=23W/mK in each case. A stainless steel fin (k=20W/mK) having a diameter of 20 mm and a length of 0.1 m is attached to a wall at 3000C. The ambient temperature is 500C and the heat transfer coefficient is 10 W/mK. The fin tip is insulated. Determine (a) the rate of heat dissipation from the fin, (b) the temperature at the fin tip, (c) the rate of heat transfer from the wall area covered by the fin was not used and (d) the heat transfer rate from the same fin

geometry if the stainless steel fin is replaced by a fictitious fin with infinite thermal conductivity

9. Two large steel plates at temperatures of 120^0C and 80^0C are separated by a steel rod 300 mm long and 25mm in diameter. The rod is welded to each plate. The space between the plates is filled with insulation, which also insulates the circumference of the rod. Because of a voltage difference between the two plates, current flows through the rod, dissipating electrical energy at a rate of 150W. Find out the maximum temperature in the rod and the heat flux. Take k for the rod as 47 W/mK.

10. A spherical metal ball of radius r_0 is heated in an oven to a temperature of 600°F throughout and is then taken out of the oven and allowed to cool in ambient air at T _ 78°F. The thermal conductivity of the ball material is k _ 8.3 Btu/h • ft • °F, and the average convection heat transfer coefficient on the outer surface of the ball is evaluated to be h _ 4.5 Btu/h • ft2 • °F. The emissivity of the outer surface of the ball is _ _ 0.6, and the average temperature of the surrounding surfaces is T_{surr} = 525 R. Assuming the ball is cooled uniformly from the entire outer surface, express the initial and boundary conditions for the cooling process of th ball.

11. Determine the heat transfer rate from the rectangular fin of length 20 cm ,width 40 cm and thickness 2 cm .The tip of the fin is not insulated and the fin has a thermal conductivity of 150 W/mK. The base temperature is 100 0C and the fluid is 20 0C .The heat transfer coefficient between the fin and the fluid is 30 W/m^2K

12. A copper fin (k=396 W/m K) 0.25 cm in diameter protrudes from a wall at 95 0C into ambient air at 25 0C.The heat transfer coefficient by free convection is equal to 10 W/m2K.Calculate the heat loss if (a) The fin is infinitely long The fin is 2.5 cm long and the coefficient at the end is same as around the circumference A solid sphere of radius 0.5 m has an interval heat generation rate of 2x10 6 W/m3.If the thermal conductivity of material is 40 W/m.K and the convective heat transfer coefficient at the surface of sphere is 100 W/m2K.Calculate the temperatures at the outer surface and at the center. Take ambient temperature as 30 0C.

13. Consider a large plane wall of thickness L _ 0.2 m, thermal conductivity k fluid is 30 W/m^2K 1.2 W/m • °C, and surface area A _ 15 m2. The two sides of the wall are maintained at constant temperatures of T1 _ 120°C and T2 _ 50°C, respectively, as shown in Figure 2–41. Determine (a) the variation of temperature within the wall and the value of temperature at x _ 0.1 m and (b) the rate of heat conduction through the wall under steady conditions

14. A Steel tube of length 20cm with internal and external diameters of 10 and 12cm is quenched from 5000 C to 300C in a large reservoir of water at 100C it is less owing to a film of vapour being produced at the surface, and an effective mean value between 5000C and 1000C is 0.5kW/m2. the density of steel is 7800kg/m3 and the specific heat is 0.47kJ/kg K. neglecting internal thermal resistance of the steel tube, determine the quenching time.

15. Steel ball bearing (k=50W/m K, ∞=1.3x10-5 m2/s) having a diameter of 40mm are heated to a temperature of 6500C and then quenched in a tank of oil 550C. If the heat transfer coefficient between the ball bearings and oil is 300W/m2 K, determine (a) the duration of time the bearings must remain in oil to reach a temperature of 2000C, (b) the total amount of heat removed from each bearing during this time and (c)the instantaneous heat transfer rate from the bearings when they are first immersed in oil and when they reach 2000C.

16. A Thermocouple, the junction of which can be approximated as a 1mm diameter of a gas stream. The properties of the junction are ρ =8500kg/m3, c=320J/kg K and k=35W/m K. The heat transfer coefficient between the junction and the gas is 210W/m2K. Determine how long it will take for the thermocouple to read 99% of the initial temperature difference.

17. A steel cylinder 0.35m diameter and 0.70m long at 200C is heated in an oven maintained at 10500C. Determine the temperatures at the centre and surface of their cylinder after an hour are to be determined. Take k=34.9W/mK,c=0.7kJ/kg K, rho=7800kg/m3 and h=232.5W/m2K.Take assumptions:1.Heat conduction in the short cylinder has thermal symmetry about the centerline. 2. The thermal properties of the cylinder and the heat transfer coefficient are constant

18. A water pipe is to be buried in soil at a sufficient depth from the surface depth from te surface to prevent freezing in winter. When the soil is at a uniform temperature of 100C the surface is subjected to a uniform temperature of -150C continuously for 50days. What minimum burial depth is needed to prevent the freezing of the pipe? Assume that ∞=0.2x10-6 m2/s for the soil and that the pipe surface temperature should not fall below 00C.

19. A cylinder steel ingot (diameter 100mm, length 300mm, k=40W/mK, ρ =7600kg/m3 and c=600J/kg K)is to be heated in a furnace from 500C to 8500C. The temperature inside the furnace is 13000C and the surface heat transfer coefficient is 100W/m2 K. calculate the time required for heating

UNIT – II

1. Differentiate between Newtonian and Non Newtonian fluids. Give examples
2. What is boundary layer thickness what do you mean by laminar and turbulent boundary layers.
3. What is critical Reynolds number for flow over flat plate
4. Define local and mean heat transfer coefficient. On what factors h value depends on
5. Write the expression for continuity equation
6. Derive the expression for Navier stokes equation
7. Derive the energy equation
8. State Buckingham pi theorem .What are the merits and demerits
9. What do you mean by VonKorman's integral method. and derive

10. drag force and heat transfer coefficient for flow over a flat plate
11. Explain Reynolds's analog 0079
12. What is physical significance of Grashoff number
13. Explain the concept of Nusselt's theory of laminar flow

PROBLEMS – II

1. Nitrogen gas at 00C is flowing over a 1. 2m long,2m wide plate maintained at 800C with a velocity of 2.5m/s., ρ=1.142kg/m3 ,cp=1.04kJ/kgK, v=15.63x10-6m2/s and k=0.0262W/mK. Find (a) The average coefficient and (b)the total heat transfer from the plate. Water at 100C flows over a flat plate (at 900C) measuring 1mx1m, with a velocity 2m/s.

2. Properties of water at 50^0C are ρ=988.10C,nu=0.556x10- 6m2/s,Pr=3.54 and k=0.648W/mK. find: (a)The length of plate over which the flow is laminar, (b)the rate of heat transfer from the entire plate..

3. Water flows through a 20mm ID at a rate of 0.01kg/s entering at 100C.The tube is wrapped from outside by an electric element that produces a uniform flux of 156kW/m2.If the exit temperature of water is 400C, estimate (a)the Reynolds number,(b)the heat transfer coefficient, (c)the length of the pipe needed, (d)the inner tube surface temperature at exit, (e)the friction factor, (f)the pressure drop in the tube, and (g)the pumping power required if the pump efficiency is 60%. Neglect entrance effects. Properties of water at mean temperature of 250C are: ρ =997kg/m3, cp=4180J/kgK, m=910x10- 6Ns/m2 and k=0.608W/mK.

4. It was found during a test in which water flowed with a velocity of 2.44m/s through a tube (2.54cm inner diameter and 6.08m long), that the head lost due to friction was 1.22m of water. Estimate the surface heat transfer coefficient based on Reynolds analogy. Take ρ =998kg/m3 and cp=4.187kJ/kgK

5. Atmospheric pressure air at 1000c enters a 0.04m dia 2m long tube with a velocity of 9m/s. A 1kW electric heater wound on the surface of the outer surface of the tube provides a uniform heat flux to the tube. find:(a)The mass flow rate of air, (b)the exit temperature of air, and (c)the wall temperature of tube at outlet.

6. Lubricating oil (ρ =865kg/m3, k=0.14W/mK and cp=1.78kJ/kgK and nu=9x10-6m2/s) at 600C enters a 1cm dia tube with a velocity of 3.5m/s. Tw=300C,constant. find: The tube length required to cool the oil to 450C. For the flow system in which air at 270C and 1atm flows over a flat plate at a velocity of 3m/s, estimate the drag force exerted on the 45cm of the plate using the analogy between fluid friction and heat transfer and also heat transfer in the plate from x=25cm to x=45c

7. Air at 2atm and 2000C is heated as it flows at a velocity of 12m/s through a tube with a diameter of 3cm. A constant heat flux condition is maintained at the wall and the wall temperature is 200C above the air temperature all along the length of the tube. Calculate (a) the heat transfer per unit length of tube. Properties of air at 2000C are Pr=0.681,µ=2.57x10- 5kg/ms,k=0.0386W/mK and cp=1.025kJ/kgK. Air at 1atm, 270C flow across a sphere of 0.015m dia at a velocity of 5m/s.A heater inside the sphere maintains the surface temperature at 770C. Find the rate of heat transfer from the sphere.

8. Water flows at a velocity of 12m/s in a straight tube of 60mm diameter. The tube surface temperature is maintained at 700C and the flowing water is heated from the inlet temperature of 150C to an outlet temperature of 450C. Taking the physical properties of water at the bulk temperature of 300C as ρ=995.7kg/m3, cp=4.174kJ/kgK, k=61.718x10-2W/mK, nu=0.805x10-6m2/s and Pr=5.42, Calculate (a)the heat surface coefficient from the tube surface to the water, (b)the heat transferred and (c)the length of the tube

9. A metal plate 0.609m in height forms the vertical wall of an oven and is at
10. a temperature of 1710C. Within the oven is air at a temperature of 93.40C and the atmospheric pressure. Assuming that natural convention conditions hold near the plate, and that for this case Nu=0.548(Gr Pr)1/4 find the mean heat transfer coefficient and the heat taken up by air per second per meter width. For air at 132.20C, take k=33.2x10- 6kW/m, µ =0.232x10-4kg/ms, cp=1.005kJ/kgK. Assume air as an ideal gas and R=0.287kJ/kgK.

11. A 0.15m o.d. steel pipe lies 2m vertically and 8m horizontally in a large room with an ambient temperature of 300C. The pipe surface is at 2500C A nuclear reactor with its core constructed of parallel vertical plates 2.2n high and 1.45m wide has been designed on free convention heating of liquid bismuth. The maximum possible heat dissipation from both sides of each plate. For the convention coefficient the appropriate correlation is Nu=0.13(Gr.Pr)1/3 where the properties evaluated at the mean film temperature of 6500C for bismuth are: ρ =104kg/m3, µ =3.12kg/m-h, cp=150.7J/kgK, k=13.02W/mK.

12. A square plate 0.4mx0.4m maintained at a uniform temperature of Tw=400K is suspended vertically in quiescent atmospheric air at 270C. Determine (a)the boundary layer thickness at the trailing edge of the plate(i.e. at x=0.4m),(b)the average heat coefficient over the entire length by using theoretical analysis .Properties of air at 350 K are nu=2.075x10- 6m2/s, Pr=0.697 and k= 0.03W/mK.

13. Determine the mean heat transfer coefficient for natural convention from the surface of a cabinet. The cabinet is mounted on a vertical wall. Its surface temperature is 1250C and the ambient temperature is 250C. What is the rate of heat loss from the surface?

14. A 50cm long fine wire of 0.02mm dia is maintained constant at 540C by an electric current when exposed to air at 00C. find the electric power necessary to maintain the wire at 540C
15. Air at 1atm and 300C is forced through a horizontal 30mm diameter 0.5m long at an average velocity of 0.25m/s. The tube wall is maintained at 1370C.Calculate (a) the heat transfer coefficient and (b) percentage error if the calculation is made strictly on the basis of laminar forced convention

16. Engine oil at 60°C flows over the upper surface of a 5-m-long flat plate whose temperature is 20°C with a velocity of 2 m/s Determine the total drag force and the rate of heat transfer per unit width of the entire plate

17. The local atmospheric pressure in Denver, Colorado (elevation 1610 m), is83.4 kPa. Air at this pressure and 20°C flows with a velocity of 8 m/s over a1.5 m 6 m flat plate whose temperature is 140°C Determine the rate of heat transfer from the plate if the air flows parallel to the (a) 6-m-longside and (b) the 1.5-m side.

18. A 2.2-cm-outer-diameter pipe is to cross a river at a 30-m-wide section while being completely immersed in water The average flow velocity of water is 4 m/s and the water temperature is 15_C. Determine the drag force exerted on the pipe by the river.

UNIT - III

1. Explain the conditions for which Dittus-Boelter equation can be used to determine heat transfer coefficient
2. What is Rayleigh number
3. What do you mean by hydrodynamic entry length?
4. Give the steps to find heat transfer in natural convection.
5. What r the assumptions to be considered for analysis of laminar
6. film condensation
7. Derive the expression for condensation heat transfer.
8. Explain different regimes of boiling heat transfer phenomena
9. Explain drop wise and film wise condensation
10. Why the condenser tubes are horizontal
11. What is nucleate boiling explain
12. Explain film boiling explain
13. Write the correlations for boiling heat transfer incase of nucleate bioling
14. Differentiate between different types of condensers
15. Write correlations for condensation heat transfer ..
16. Explain what do you mean by absorptivity ,reflectivity and transmissivity
17. Define Opaque body and black body
18. Define momochromatic emissive power and total emissive power
19. What are the basic laws of radiation.
20. What is shape factor obtain the expression for it
21. Derive expression for radiant energy between two small gray surfaces

22. Explain radiosity
23. Explain irradiation
24. Write expression for monochromatic emissive power
25. Write expression for blackbody radiation.

PROBLEMS – III

1. Saturated steam at 54.50C condenses on the outside surface of a 25.4mm outer diameter 3.66m long vertical tube maintained at a uniform temperature of 43.30C. Because of the occurrence of ripples on the surface of the condensate film the actual heat transfer coefficient 20% higher than the obtained by Nusselt's equation. Determine the average condensation heat transfer coefficient over the entire length of the tube and the rate of condensate flow at the bottom of the tube. Check that the flow is laminar. The properties of condensate at 48.90C are h_{fg}=2372.4 kJ/kgK, k=0.642W/mK, ρ =988.4kg/m^3 and μ =0.558x10^{-3}kg/ms.

2. Saturated steam at 1100C condenses on the outside of a bank of 64 horizontal tubes of 25mm outer diameter; 1m long arranged 8x8 square arrays. Calculate the rate of condensation if the tube surface is maintained at 1000C. The properties of saturated water at 1050C are ρ=654.7kg/m3, k=0.684 W/m^2K, μ=271x10-6 Kg/mS and h_{fg}=2243.7kJ/kg.

3. A Vertical plate 300mm wide and 1.2m high is maintained at70^{0}C and is exposed to saturated steam at 1atm pressure. Calculate the heat transfer coefficient and the total mass of steam condensed per hour. What would be the heat coefficient if the plate is inclined at 30^{0}C to the vertical?

4. Estimate the power required to boll water in a copper pan, 0.35m in diameter. The pan is maintained at 120^{0}C by an electric heater. What is the evaporation rate? Estimate the critical heat flux

5. A metal-clad heating element of 8mm diameter and emissivity 0.9 is horizontally immersed in a water bath. The surface temperature of the metal is 260^{0}C under steady-state boiling conditions. Estimate the power dissipation per unit length of heater Water is to be boiled at atmospheric pressure in a mechanically polished stainless steel pan placed on top of a heating unit. The inner surface of the bottom of the pan is maintained at 108°C. If the diameter of the bottom of the pan is 30 cm, determine (a) the rate of heat transfer to the water and (b) the rate of evaporation of water
6. Water in a tank is to be boiled at sea level by a 1-cm-diameter nickel plated steel heating element equipped with electrical resistance wires inside, in. Determine the maximum heat flux that can be attained in the nucleate boiling regime and the surface temperature of the heater surface in that case. Water is boiled at atmospheric pressure by a horizontal polished copper heating element of diameter D=5 mm and emissivity € 0.05 immersed in water, If the surface temperature of the heating wire is350°C, determine the rate of heat transfer from the wire to the water per unit length of the wire.

7. Saturated steam at atmospheric pressure condenses on a 2m high and 3m wide vertical plate that is maintained at 80°C by circulating cooling water through the other side. Determine (a) the rate of heat transfer by condensation to the plate and (b) the rate at which the condensate drips off the plate at the bottom. What would your answer be to the preceding example problem if the plate were tilted 30° from the vertical,

8. A domestic hot water (0.5m diameter and 1m high) is installed in a large space. The ambient temperature is 25^0C. If the surface is oxidized copper with an emissivity of 0.8, find the heat loss from the tank surface at temperature 80^0C by radiation. What would be the reduction in heat loss if a coating of aluminum paint having an emissivity of 0.3 is given to the tank? What would be the increase in heat loss if a white paint having an emissivity of 0.97 is given to the tank?

9. A black body emits radiation at 2000 K. Calculate (i) the monochromatic emissive power at 1 µ.m wavelength,(ii) wavelength at which the emission is maintained and (iii)the maximum emissive power The filament of a 75W light bulb may be considered a black body radiating into a black enclosure at 70^0C.the filament diameter is 0.10mm and the length is 50mm. Considering the radiation, determine the filament temperature.

10. An enclosure measures 1.5mx1.7m with a height of 2m. The walls and ceiling are maintained at 250^0C and the floor at 130^0C.The walls and ceiling have an emissivity of 0.82 and the floor 0.7.Determine the net radiation to the floor.

11. Two black discs 1m in diameter are placed directly opposite to each other at a distances 0.5m.The discs are maintained at 1000 K and 500 K respectively. Calculate the heat flow between the discs (a) when no other surfaces are present and (b)when the discs are connected by a cylindrical refractory no- flux surface

12. In a cylindrical; furnace 0.6m in diameter and 1m high, the upper surface is maintained at 727^0C and the lower surface is maintained at 427^oC.Assuming the cylindrical wall to be a refractory surface and if the emissivity's of the upper and lower surfaces are 0.8 and 0.7 respectively, estimate the net rate of radiative energy transfer from the u upper tip the lower surface.

UNIT - IV

1. Classify heat exchangers
2. What are the applications of heat exchangers..
3. What do you mean by fouling factor..causes of fouling
4. What are shell and tube heat exchangers?
5. Derive LMTD for parallel flow heat exchangers
6. Derive LMTD for counter flow heat exchangers
7. Define effectiveness and NTU of heat exchanger
8. Derive expression for effectiveness of parallel flow heat exchanger
9. Derive expression for effectiveness of counter flow heat exchanger

10. Derive NTU of parallel flow and counter flow heat exchangers. ..

PROBLEMS – IV

1. In an oil cooler, oil enters at 160^0C. If the water entering at 35^0C flows Parallel to oil, the exit temperatures of oil and water are 900C and 70^0C respectively. Determine the exit temperatures of oil and water if the two fluids in opposite directions. Assuming that the flow rates of the two fluids and U_0 remain unaltered. What would be the minimum temperatures to which oil could be cooled in parallel flow and counter flow operations?

2. In an open heart surgery under hypothermic conditions, the patient's blood is cooled before the surgery and re warmed afterwards. It is proposed that a concentric tube counter flow heat exchanger of length 0.5m is to be used for this purpose, with a thin-walled inner tube having a diameter of 55mm.If water at 600C and 0.1kg/s is used to heat blood entering the exchanger and the heat flow rate. Take U0=500 W/m^2 K, cp of blood=3.5kJ/kg K and cp of water 4.183kJ/kg K.

3. A flow of 0.1kg/s of exhaust gases at 700 K from a gas turbine is used to preheat the incoming air, which is at the ambient temperature of 300K. It is desired to cool the exhaust to 400 K and it is estimated that an overall heat coefficient of 30 W/m2K can be achieved in an appropriate exchanger.

4. Determine the area required for a counter flow heat exchanger. Take the specific heat of exhaust gasses the same as for air, which is 1000 J/kgK. After a long time in service, a counter flow oil cooler is checked to ascertain if its performance has deteriorated due to fouling. In the heat transfer surface is 3.33m2 and the design value of the overall heat transfer coefficient is 930 W/m^2K, how much has it been reduced by fouling? Cp of oil as 2330 J/kg K and cp of water as 4174 J/kgK.
5. A brass (k=111W/mK) condenser tube has a 30mm outer diameter and 2mm wall thickness. sea water enters the tube at 290K and the saturated low pressure steam condenses on the outer side of the tube. The inside and outside heat transfer coefficients are estimated to be 4000 and 8000 W/m^2K, respectively and a fouling resistance of 10^{-4}(W/m^2K) on the water side is expected. Estimate the overall heat transfer coefficient based on inside area.

6. A chemical having specific heat of 3.3kJ/kgK flowing at the rate of 20000 kg/h enters a parallel flow heat exchanger at 120^0C. The flow rate of cooling water is 50000 kg/h with an inlet temperature of 20^0C.The heat transfer area is $10m^2$ and the overall heat transfer coefficient is 1050 W/m^2K. Find (i) the effectiveness of the heat exchanger, (ii) the outlet temperatures of water and chemical. Take for water cp=4.186kJ/kgK

7. In a double-pipe counter flow heat exchanger the inner tube has a diameter of 20mm and very little thickness. The inner diameter of the outer tube is 30mm.Water flows through the inner tube at a rate of 0.5kg/s and the oil flows through the shell at a rate of 0.8kg/s. Take the

8. average temperatures of the water and the oil as 470C and 800C respectively and assume fully developed flow. Determine the overall heat transfer coefficient. Given: for water at 470C, ρ=0.637W/mK, nu=$0.59 \times 10^{-6} m^2/s$ and Pr=3.79. For oil at 80^0C, ρ=$852 kg/m^3$, k=0.138W/m K , nu =$37.5 \times 10^{-6} m^2/s$ and Pr= 490.

9. The condenser of a large steam power plant is a shell-and-tube heat exchanger having a single shell and 30000 tubes, with each tube making two passes. The tubes are thin-walled with 25mm diameter and steam condenses on the outside of the tubes with $h_0=11 kW/m^2K$. The cooling water flowing through the tubes is 30000 kg/s and the heat transfer rate is 2 GW. Water enters at 20^0C while steam condenses at 50^0C. Find the length of the tubes in one pass. Properties of water at 27^0C are cp=4.18kJ/kgK, μ =$855 \times 10^{-6} Ns/m^2$, k=0.613 W/mK and Pr=5.83

10. A double-pipe (shell-and-tube) heat exchanger is constructed of a stainless steel(k = 15.1 W/m°C) inner tube of inner diameter D_i =1.5 cm and outer diameter D_o = 1.9 cm and an outer shell of inner diameter 3.2 cm. The convection heat transfer coefficient is given to be h_i= 800 W/m^2 °C on the inner surface of the tube and h_o=1200 W/m^2°C on the outer surface. For a fouling factor of R_{fi}= 0.0004 m^2°C/ W on the tube side and R_{fo} = 0.0001 m^2°C/ W on the shell side, determine (a) the thermal resistance of the heat exchanger per unit length and (b) the overall heat transfer coefficients, U_i and U_o based on the inner and outer surface areas of the tube, respectively

11. Steam in the condenser of a power plant is to be condensed at a temperature of30°C with cooling water from a nearby lake, which enters the tubes of the condenser at 14°C and leaves at 22°C. The surface area of the tubes is 45 m2, and the overall heat transfer coefficient is 2100 W/m^2°C. Determine the mass flow rate of the cooling water needed and the rate of condensation of the steam in the condenser.

UNIT - V

1. Derive the general mass transfer equation in cartesian coordinates.

2. The molecular weight of the two components A and B of a gas mixture are 24 and 28 respectively. The molecular weight of gas mixture is found to be 30. If the mass concentration of the mixture is $1.2 kgm^3$, determine the following:

(i) Molar fractions (ii)Mass fractions, and(iii) Total pressure if the temperature of the mixture is 290K

3.A vessel contains a binary mixture of O_2 and N_2 with partial pressures in the ratio 0.21 and 0.79 at 15^0C. The total pressure of the mixture is 1.1 bar. Calculate the following:

(i) Molar concentrations (ii) Mass densities (iii) Mass fractions and (iv) Molar fractions of each species.

4. From the data given below, calculate the diffusion coefficient for NH_3 in air at 27^0C temperature and atmospheric pressure:

NH_3 (Gas A): Molecular weight=17 Molecular volume=26.43 cm^3/gm mole

Air (Gas B): Molecular weight=29 Molecular volume=30.6 cm^3/gm mole

5. A steel rectangular container having walls 16 mm thick is used to store gaseous hydrogen at elevated pressure. The molar concentrations of hydrogen in the steel at the inside and outside surfaces are 1.2 kg mole/m^3 and zero respectively. Assuming the diffusion coefficient for hydrogen in steel as 0.248×10^{-12} m^2/sec, calculate the molar diffusion flux for hydrogen through the steel.

6. Hydrogen gas is maintained at pressure of 2.4 bar and 1 bar on opposite sides of a plastic membrane 0.3 mm thick. The binary diffusion coefficient of hydrogen in the plastic is 8.6×10^{-8} m^2/s and solubility of hydrogen in the membrane is 0.00145 kg mole/m^3-bar. Calculate, under uniform temperature conditions of 24^0C, the following:

(i) Molar concentrations of hydrogen at the opposite faces of the membrane, and

(ii) Molar and mass diffusion flux of hydrogen through membrane.

7. Hydrogen gas at 25^0C and 2.5 atmosphere flows through a rubber tubing of 12 mm inside radius and 24 mm outside radius. The binary diffusion coefficient of hydrogen is 2.1×10^{-8} m^2/s and the solubility of hydrogen is 0.055 m^3 of hydrogen per m^3 of rubber at 1 atmosphere. If the gas constant for hydrogen is 4160 J/kg K and the concentration of hydrogen at the outer surface of tubing is negligible, calculate the diffusion flux rate of hydrogen per meter length of rubber tubing.

8. Air is contained in a tyre of tube of surface area 0.5 m^2 and wall thickness 10 mm. The pressure of air drop from 2.2 bar to 2.18 bar in a period of 6 days. The solubility of air in the rubber is 0.072m^3 of air per m^3 of rubber at 1 bar. Determine the diffusivity of air in rubber at the operating temperature of 300 K if the volume of air in the tube is 0.028 m^3.

9. A 30 mm deep pan is filled with water to a level of 15 mm and is exposed to dry air at 40^0C. Assuming the mass diffusivity as $0.25 \times 10^{-4}$$m^2$/s, calculate the time required for all the water to evaporate.

10. Air at 1 atm and 25ºC, containing small quantities of iodine, flows with a velocity of 6.2 m/s inside a 35 mm diameter tube. Calculate mass transfer coefficient for iodine. The thermo physical properties of air are: $v=15.5 \times 10^{-6}$ m^2/s; $D=0.82 \times 10^{-5}$ m^2/s.

REFRIGERATION AND AIR-CONDITIONING

UNIT-1

1. Define the unit of refrigeration.
2. What are the applications of refrigeration?
3. How is ideal reversed carnot cycle modified to result in Bell Column cycle?
4. What are the factors to be considered for the adoption of a refrigeration system for an aircraft?
5. Explain the Boot strap refrigeration system with a schematic and cycle diagram. Derive the expression for the C.O.P. of Bell Column cycle.

UNIT-2

1. Derive an expression for C.O.P of vapor compression cycle from t-s chart when the refrigerant is dry saturated before compression.

2. An air refrigeration used for fool storage provides 25 TR./ The temperature of air entering the compressor is 7 0 and the temperature at exit of cooler is 27 0 C. Find : 1.C.O.P. of cycle, 2. Power per tonne of refrigeration required by the compressor. The quantity of air circulated in the system is 3000 kg/h. The compression and expansion both follows the law pv 1.3 = constant and take Y= 1.4; and c p = 1 kJ/kg K for air.

3. Explain the working principle of vapor compression refrigerant.

4. In an open air refrigeration machine, air is drawn from a cold chamber at -2 0 c and 1 bar and compressed to 11bar. It is then cooled at this pressure, to the cooler temperature of 20 0 c and then expanded in expansion cylinder and returned to the cold room. The compression and expansion are isentropic, and follows the law pv 1.4 =constant. Sketch the p-v and T-s diagrams of the cycle and for a refrigeration of 15 tonnes, find 1. theoretical C.O.P 2. Rate of circulation of the air in kg/min 3. Piston displacement per minute in the compressor and expander 4. Theoretical power per tonne of refrigeration.

5. Discuss the advantages of dense air refrigeration system over an open air refrigeration system.

UNIT-3

1. Explain the working principle of steam jet refrigeration system?
2. Explain the working principle the vapour absorption refrigeration system?
3. Explain the working principle Three fluid absorption refrigeration system?
4. Explain the working principle Practical vapour absorption system?
5. Explain the working principle Hydrogen-water system?

UNIT-4

1. (a) Represent the following process in a skeleton psychrometric chart.
   i. Sensible cooling ii. Cooling and humidification iii. Adiabatic mixing of air streams.

   (b) Ten grams of moisture per kg of dry air is removed from atmospheric air when it is passed through an air conditioning system and its temperature becomes 20^0C. The atmospheric conditions are 40^0C DBT and 60% RH. Calculate the following for the conditioned air. i. Relative humidity, ii. Wet-bulb temperature, iii. Dew point temperature, iv. Enthalpy change for the air. Assume standard atmospheric pressure.
2. a) When is dehumidification of air necessary and how it is achieved?
   b) 120 m^3 of air per minute at 35^0C DBT and 50% R.H is cooled to 20^0C DBT by passing through a cooling coil Determine the following
   R.H of out coming air and its WBT
   ii Capacity of the cooling coil in tons of refrigeration
   iii Amount of water vapor removed per hr.
   iv ADP.
3. Define
   i. Partial pressure of water vapour
   ii. DPT
   iii. RHand
   iv. Degree of saturation.
4. The atmospheric air at 180C DBT and 70% RH is supplied to the heating chamber at the rate of $120m^3$/min. The leaving air has a temperature of 24^0C without change in its moisture contents. Determine the heat added to the air per minute and final RH of the air.
5. a) Write a short note on the bypass factor of the cooling coils.
   b)The sensible heat factor of an air-conditioned room is 0.67. The condition of the air leaving the air-conditioned room is 27^0C DBT and 52% RH. The maximum permissible temperature difference between the inlet air and outlet air is 11^0C. If the quantity of air flow at the inlet of the room is $180m^3$/min, then determine the sensible and latent heat load of air conditioned room.
6. a) Explain the procedure to construct the RSHF line on a psychrometric chart.
   b) 800 m^3/min. of recirculated air at 22^0C DBT and 10^0C DPT is to be mixed with 300 m^3/min. of fresh air
   i. at 30^0C DBT and 50% RH. Determine the enthalpy, specific volume, humidity ratio and DPT of the mixture.

UNIT-5

1. a) What are the sources of heat in nature which can be used for heat pumps?
   b) Discuss about the performance of Heat pump when used with the different sources of heat. State the advantages and disadvantages in each case.
2. a) Differentiate between the unitary and central air conditioning system

   b) The amount of air supplied to air conditioned hall is 300 m^3/min. The atmospheric conditions are 35^0C DBT and 55% RH. The required conditions are 20^0C DBT and 60% RH, determine, the sensible heat and latent heat removed from the air per minute. Also, find SHF for the system.

3. a) Explain the summer air conditioning system with a neat sketch.
   b) Explain the procedure of construction of comfort chart.
4. An air conditioned plant is to be designed for a small office for winter conditions: Outdoor conditions are 10^0C DBT and 8^0C WBT, required indoor conditions are 20^0C DBT and 60% RH, amount of air circulation is 0.3 m^3/min./person, seating capacity of the office is 50 persons. The required condition is achieved first by heating and then by adiabatic humidifying, determine; i. Heating capacity of the coil in KW and the surface temperature; if the by-pass factor of the coil is 0.32; and ii. Capacity of the humidifier.
5. a) List out different sources that contribute to the sensible heat load of the room to be air conditioned.
6. Give the classification of the effects of heat on human body? Explain briefly.
7. Briefly explain the thermodynamics of human body.

PRODUCTION OPERATION MANAGEMENT

UNIT-1

1. What is operations management and role of operations management.
2. Differentiate between Product life cycle Process life cycle.
3. Explain about PPC and briefly explain the functions of PPC.
4. Write a short note on process technology and its characteristics.
5. Write in detail about Product design.
6. Write a brief note on Historical Evolution of Production and Operations Management.
7. Explain batch production and mass production along with its advantages and disadvantages

UNIT-2

1. Define Plant layout. Discuss the relative merits and demerits of product and process layout.
2. Discuss the factors affecting the plant layout
3. Explain about the Process and Product layout in detail.
4. Write about MPS in detail.
5. Write about aggregate planning and explain the inputs and outputs.
6. What do you understand by Operations Scheduling? What are the problems faced in the absence of proper scheduling
7. Explain product and process layout in detail with its advantages and disadvantages
8. Explain types of layout with examples
9. How does flexible manufacturing system differ from cellular layout

UNIT-3

1. Explain about method study and work study in detail.
2. Explain variour techniques in method study.
3. Write in detail about quality assurance.
4. Explain about the quality circles.

UNIT-4

1. Explain about materials requirement planning.
2. Explain about the inputs and outputs of Materials Requirement Planning.

3. Explain about vendor rating and the determinants of vendor rating.
4. “ Make or buy decisions” explain this statement.
5. Explain the term waste management.

UNIT-5

1. Explain the ABC analysis technique of Inventory Control
2. Write down the difference between PERT and CPM
3. Explain the VED analysis technique of Inventory Control
4. Explain the types of inventory systems in detail.
5. what are requirements for efficient store management and what are its objectives.