Roll No. | | | | | | | | | | |

**B.E / B.Tech ( Full Time ) DEGREE END SEMESTER EXAMINATIONS, APRIL / MAY 2014**

**MECHANICAL ENGINEERING**

**VI Semester**

**ME 9355 HEAT AND MASS TRANSFER**

(Regulation 2008)

**USE OF HMT DATA BOOK AND STEAM TABLES IS PERMITTED**

Time: 3 Hours | Answer ALL Questions | Max. Marks 100

**PART-A (10 x 2 = 20 Marks)**

1. What is the functional meaning of the term "infinite fin".
2. Define time constant for a temperature sensor.
3. What do you mean by Reynolds colburn analogy
4. When water at a mean temperature of 40°C flows through a square tube 5m long, the flow is fully developed and the wall temperature is maintained at 90°C. What will be the convective heat transfer coefficient
5. Explain why the Fluorescent lamps are more efficient than incandescent bulbs.
6. What is the law of superposition applicable to shape factor in Radiative heat transfer?
7. Draw the Pool boiling heat transfer characteristics curve and mark the critical heat flux and Leidenfrost point
8. Draw and indicate the regimes of heat transfer experienced in flow boiling.
9. Helium diffuses through a plane, plastic membrane 1 mm thick. The concentration of helium in the membrane is 0.02 k mol/$m^3$ at the inner surface and 0.005 k mol/$m^3$ at the outer surface. If the binary diffusion coefficient of helium with respect to the plastic is $10^{-9}$ $m^2/s$, what is the diffusion flux of helium through the plastic?
10. Differentiate between convective and diffusion mass transfer.

**Part – B ( 5 x 16 = 80 marks)**

11. 55 kg/s of steam is flowing through a convective steam superheater 35/45 mm in diameter made of steel (k= 38.5 W/m°C). The pressure of dry saturated steam at the inlet of the superheater is 120 bar. The temperature of the steam leaving the superheater is 480°C. The heat transfer coefficient from the gas to wall and from wall to steam are 82 W/$m^2$°C and 1120 W/$m^2$°C respectively. If the mean flue gas temperature is 920°C, determine the outer heating surface area of the super-heater. Take:$C_{ps}$(for steam) = 1.92 kJ/kg°C.

12. a) A thermometer pocket is inserted in a pipe of 150mm diameter carrying hot air. The pocket is made of brass (k = 70 W/m°C). The inner and outer diameter of the pocket are 10 mm and 15 mm respectively. The heat transfer coefficient between the pocket and air is given by
Nu = 0.174 $(Re)^{0.618}$ , Reynolds number (Re) of air flow = 25000
Take k (air) = 0.035 W/m°C and depth of pocket = 50 mm
Find the actual error in temperature measurement if the pipe wall is at 50°C and air

temperature is 150°C.

**(OR)**

b) The dry bulb and wet bulb temperature recorded by a thermometer in moist air are 27°C and 17°C respectively. Determine the specific humidity of air assuming the following values.

$Pr = 0.74$, $Sc = 0.6$, $C_p = 1.004 kJ/kg.K$, $p = 1.0132 \times 10^5 N/m^2$

13. a) A 1-shell 2 tube pass steam condenser consists of 3000 brass tubes of 20 mm diameter. Cooling water enters the tubes at 20°C with a mean flow rate of 3000 kg/s. The heat transfer coefficient for condensation on the outer surfaces of the tubes is 15500 $W/m^2.K$. If the heat load of the condenser is $2.3 \times 10^8$ W when the stem condenses at 50°C determine $h_i$ and estimate

(a) the outlet temperature of the cooling water
(b) the overall heat transfer coefficient
(c) the tube length per pass using the NTU method.
(d) the rate of condensation of steam if $h_{fg} = 2380$ kJ/kg.

**(OR)**

b) A cross flow type heat exchanger with steam condensing inside tubes at 100°C is used to heat air from 20°C. The air side may be taken as mixed. The effectiveness of the heat exchanger is found as 0.7. If the area is $20 m^2$ and overall heat transfer coefficient based on this area is 150 $W/m^2K$, determine the heat transfer rate. Determine the extra area required if a fouling resistance of 0.0006 $m^2K/W$ is experienced.

14. a) In an industrial facility, air is to be preheated before entering a furnace by geothermal water at 120°C flowing through the tubes of a tube bank located in a duct. Air enters the duct at 20°C and 1 atm with a mean velocity of 4.5 m/s, and flows over the tubes in normal direction. The outer diameter of the tubes is 1.5 cm, and the tubes are arranged in line with longitudinal and transverse pitches of $S_L = S_T = 5$ cm. There are 6 rows in the flow direction with 10 tubes in each row. Determine the rate of heat transfer per unit length of the tubes.

**(OR)**

b) Water is to be heated from 15°C to 65°C as it flows through a 3 cm internal diameter 5 m long tube. The tube is equipped with an electric resistance beater that provides uniform heating throughout the surface of the tube. The outer surface of the heater is well insulated, so that in steady operation all the heat generated in the heater is transferred to the water in the tube. If the system is to provided hot water at a rate of 10 L/min, determine the power rating of the resistance heater. Also estimate the inner surface temperature of the tube at the exit.

15. a) Two identical circular plates each with area $1 m^2$ and emissivity 0.5 are arranged facing each other in a large room. The emissive power of the plates are 30 $kW/m^2$ and $3 kW/m^2$ respectively. The temperature of the surrounding is 27°C. The surface of the plates facing each other only are radiating energy, find

(i) Distance between the plates;
(ii) Temperature of the plates;
(iii) Heat transfer to the surrounding from the plates.

Assume the shape factor between the plates as 0.6.

**(OR)**

b) Determine the number of shields required to be fixed in between the outer and inner walls (of a furnace) that are to be maintained at 100°C and 500°C respectively if the emissivity of the wall lining as well as for shield is 0.87.

Heat transfer to the surroundings from the outer surface takes place by radiation and convection. The heat transfer coefficient for natural convection is given by

$h_a = 1.44 (\Delta t)^{0.33} W/m^{2\circ}C$

$T_a$ (air temperature) = 25°C

Neglect the heat transfer by conduction and convection between the brick lining.

B.E / B.Tech (Full Time) DEGREE END SEMESTER EXAMINATION, APR /MAY 2014

MECHANICAL ENGINEERING BRANCH

Sixth Semester – (R-2008)

ME 9353 – DESIGN OF TRANSMISSION SYSTEMS

*(APPROVED DESIGN DATA BOOK PERMITTED)*

**TIME: 3 hrs** **ANSWER ALL QUESTIONS** **MAX MARKS: 100**

## PART – A (10X2 = 20 Marks)

1. What does it mean by crowning of pulleys and why it is being done?
2. State the conditions to be followed while installing flat belt.
3. Classify brakes based on the application of direction of breaking force.
4. Write the reasons for considering load concentration factor and dynamic load factor in the design of gear pairs.
5. What is known as a corrected gear?
6. Differentiate axial pitch and normal pitch of a helical gear.
7. Why cone clutches are better than disc clutches?
8. What are known as mitter gears?
9. What will happen, when lead angle of the worm is greater than the friction angle of the surfaces in contact?
10. (i) The speeds of gears of a gear box is in geometric progression in order to maintain -------- as minimum.

    (ii) In a gear- box, for a set of gears, if the centre distance and module are same, then the sum of teeth of engaging pair will be .....

## PART – B (5 X 16 = 80 Marks)

11. Design a nine speed gear box for a milling machine with speeds ranging from 56 to 900 rpm. The input speed is 720 rpm. Make a neat sketch of gear box and indicate the number of teeth on all the gears and speeds. For each stage, assume the number of teeth on driver as 20. Ensure standard step ratio.

12. (a) Two spur gears are to be used for a rock crusher drive and are to be of minimum size. Gears are to be designed for the following requirements. Power to be transmitted = 18 kW, speed of pinion 1200 rpm, angular velocity ratio =3.5: 1, tooth profile 20° stub. Assume that gears are made of case hardened alloy steel (15 Ni2 Cr1 Mo15), life of 20,000 hrs, symmetric scheme, rotation in one direction, IS quality 8, surface hardness greater than 350HB and pinion tooth as 16. Design the drive.

(OR)

12. (b) A general purpose enclosed gear train is based on parallel helical gears, specified life is 36,000 hrs. Torque at driven shaft is 411 Nm. Driving shaft speed is 475 rpm. Velocity ratio is 4. It is desired to have ***standard centre distance.*** Assume both pinion and gear are made of 40 Ni2 Cr1 Mo 28, helix angle = 10°, $\psi = 0.5$, $Z_1 = 17$, surface hardness greater than 350HB and IS quality 6.

13. (a) Design a bevel gear to transmit 3.5 kW. Speed ratio = 4. Driving shaft speed = 200 rpm. The drive is non reversible. Pinion is of steel C45 and wheel is of CI grade 30 ($\sigma_U$ = 300 N/mm$^2$) with FOS 2.5 and average HB value. Assume life of 25000 hrs, surface hardness greater than 350HB for pinion with 18 teeth, IS quality 8 and $\psi_y$ = 3.

(OR)

13. (b) Design a worm gear drive to transmit 22.5 kW power at a worm speed of 1440 rpm, velocity ratio 24:1. Minimum efficiency required is 85%. Assume the worm and wheel is made of steel and sand cast bronze respectively and initial sliding velocity as 3 m/s.

14. (a) A V – belt drive is to transmit 20 kW from a V – pulley of 250 mm pitch diameter operating at 1800 rpm to a 900 mm diameter flat pulley. The centre distance between the input and output shafts is 1 m. The groove angle is 40°. The co efficient of friction between belt and V pulley and that between belt and flat pulley are same and equal to 0.2. The cross section of the belt is 38 mm wide at the top, 19 mm wide at the bottom and 23 mm deep. If single belt weighs 11 kN/m$^3$ and allowable tension per belt is 900 N, calculate number of belts required and determine which pulley governs the design? Belt thickness should be considered in lap angle calculation.

(OR)

14. (b) Design a chain drive subjected to variable mild shock loads, to run a compressor from a 11 kW electric motor running at 970 rpm. The compressor speed is 330 rpm and the compressor operates 16 hrs/day. The center distance should be approximately 500 mm. The sprockets are horizontal, drops lubricated. The chain tension can be adjusted by shifting the motor on slides. $Z_1$ can be assumed on the higher side of i and pitch value nearer to $p_{max}$ may be selected for quicker solution.

15. (a) A leather faced conical clutch has cone angle of 30°. The pressure between the contact surfaces is limited to 0.35 N/mm$^2$ and the breadth of the conical surface is not to exceed 1/3 of the mean radius. Find the dimensions of the contact surfaces to transmit 22 kW at 2000 rpm. Also calculate the force required to engage the clutch. Take co efficient of friction as 0.15. Assume uniform wear theory and service factor 2.5.

(OR)

15. (b) A 360 mm radius brake drum contacts a single shoe as shown below and sustains 225 Nm torque at 500 rev/min. For a co efficient of friction of 0.3 determine (a) The required force F to apply the brake for clockwise and anti clock wise rotation (b) The dimension c required to make the brake self locking, assuming the other dimensions remain as shown (c) the rate of heat generated.