Maximum Marks: 60                                      Credits: 04                                      Duration: Three Hours

Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No.                        Question                                                                                                    M.M.
1(a)  Explain the working of an tacho-generator and also derive its transfer function. Which type of systems can be represented by transfer function?  [06]
1(b)  For the rotational system shown in figure 1, find out the transfer function $\theta_1(s)/T(s)$. [06]

1(b') Show that by providing negative feedback in a control system the gain sensitivity can be reduced and an unstable system can be made stable. [06]

2(a)  What is Mason’s Gain Formula?

2(b)  Find forward path gains, loop gains and non-touching loops for the system whose signal flow graph is given in figure 2 and hence also find the transfer function. [06]

2(b)  Find out the transfer function $C(s)/R(s)$ of the system shown in figure 3 using block diagram reduction technique. [06]

Contd.....2.
3(a) Define State Vector. Discuss the significance of State Space representation and its advantages over other methods of system representation.

3(b) A system is described by the following differential equation:

\[
\frac{d^3y}{dt^3} + 6 \frac{d^2y}{dt^2} + 11 \frac{dy}{dt} + 10y = 8u(t)
\]

Where \( y \) is the output and \( u \) is the input to the system. Obtain the state space representation of the system.

OR

3(b') Determine the controllability and observability of the system described by the state equations:

\[
\begin{bmatrix}
    x_1' \\
    x_2'
\end{bmatrix} = \begin{bmatrix}
    -0.5 & 0 \\
    1 & -2
\end{bmatrix} \begin{bmatrix}
    x_1 \\
    x_2
\end{bmatrix} + \begin{bmatrix}
    0 \\
    1
\end{bmatrix} u(t), \text{ and}
\]

\[
y(t) = \begin{bmatrix}
    0 & 1
\end{bmatrix} \begin{bmatrix}
    x_1 \\
    x_2
\end{bmatrix}
\]

4(a) Derive the response \( c(t) \) of a second order system when it is subject to step input. Also show the location of roots of the characteristic equation on s-plane for various types of system responses.

4(b) What is root locus? Write down the steps for sketching root locus plot.

OR

4'(a) The closed loop transfer function of a second order system is given by:

\[
\frac{C(s)}{R(s)} = \frac{16}{s^2 + 5s + 16}
\]

Determine the rise time, peak time and maximum overshoot of the system for unit step input.

4'(b) Sketch the root locus plot for a system having open loop transfer function given by:

\[
F(s) = \frac{K(s + 2)}{(s + 1 + j4)(s + 1 - j4)(s + 3)(s + 4)}
\]

5(a) Explain the functions of Proportional, Derivative and Integral Controllers in a control system.

5(b) A system has the characteristic equation:

\[
s^5 + 4s^4 + 8s^3 - 8s^2 + 7s + 4 = 0
\]

Using Routh Hurwitz criteria check system stability.

OR

5(b') Construct Bode plot of the system whose open-loop transfer function is given by:

\[
G(s) = \frac{100}{s(1 + 0.1s)(1 + 0.2s)}
\]

Find out Gain Margin, Phase Margin and comment on the stability of the system.
2015-2016
B.E. (AUTUMN SEMESTER) EXAMINATION
MECHANICAL ENGINEERING
MACHINE DESIGN
EME-317

Maximum Marks: 60 Credits: 04 Duration: Three Hours

Answer all questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No. Question M.M.
1(a) What are the different types of welding processes? Also state the limitations of welded joints. (04)
1(b) An eccentric loaded joint is shown in Fig. 1. Determine the size of the fillet weld. The allowable shear stress of the weld material is 100 MPa. (08)

2. (a) Explain different types of lubrication. Also explain the pressure generation mechanism in a hydrodynamic bearing. (04)

2. (b) It is required to find the load carrying capacity of a hydrodynamic journal bearing having the length of journal as 50 mm. Take absolute viscosity of the oil at operating temperature as 20×10^{-3} Pa s, journal speed 1440 rpm, L/D = 1, radial clearance = 0.05 mm and minimum film thickness = 0.0125 mm. Also determine power lost in friction and oil temperature, if whole of the heat can be dissipated. Use Lasche’s constant K = 0.484 °C m^2/W. (08)

2'. (a) Define basic static load rating, rating life, basic dynamic load rating, equivalent dynamic load with reference to rolling element bearings. (04)

2'. (b) The shaft shown in Fig. 2 has parallel belt pulls, with tension on loose side of pulley 4 being 30 percent of the tension on the tight side. The shaft rotates at 840 rpm and radial ball bearings to be selected at O and B are to have 98% reliability corresponding to a life of 30 K hrs. The diameters of the shaft at bearings O and B is 25 mm. Find the dynamic load capacities of the bearings at O and B. (08)

3. (a) Draw the modified Soderberg diagram used for the design of helical compression springs. Hence derive the expression for the factor of safety. (04)

3. (b) A helical compression spring carries a fluctuating load varying from 428 N to 642 N. The spring index is 6 and factor of safety is 1.5. Shear yield strength is 600 MPa and shear endurance limit is 350 MPa of the spring material. Calculate the spring wire...
diameter and number of effective turns, if deflection due to variation in load is 4 mm. Take \( G = 84 \text{ GPa} \).

\text{OR}

3'.(a) What is nipping in leaf springs? Find the expression of initial preload required to close the nip so that stress in all the leaves is equal.

3'.(b) A helical torsion spring is made of hard drawn steel wire of 2 mm diameter. The yield strength is 70% of the ultimate strength and the factor of safety is 2.0. Due to space limitations, the outside diameter is 17 mm. The maximum bending moment is 300 N-mm. Determine number of active coils and angular deflection. Spring rate is 300 N-mm/radian. \( E = 2.08 \times 10^5 \text{ N/mm}^2 \) and \( \sigma_{y} = 1783 \text{ N/mm}^2 \).

4 (a). Power is being transmitted from a pair of helical gears. Hence, derive the components of the total (normal) tooth force.

4. (b) Two parallel shafts are connected by a pair of helical gears. The power transmitted is 5 kW at 2000 rpm of pinion. Normal pressure angle is 20° and helix angle is 15°. Both pinion and gear are made of hardened steel with \( \sigma_p = 220 \text{ MPa} \). Design the gears. Gear ratio is 4:1. Take face width \( b = 12.5 \text{ mm} \). Assume number of teeth on pinion 25. The first preference of normal modules are: 1, 1.25, 1.5, 2, 2.5, 3, 4, 5, 6, 8 and 10.

5. (a) What is functional difference between a brake and a clutch? Write different types of shoe brakes and band brakes and draw their figures.

5. (b) An automotive (internal type) expanding shoe brake is shown in Fig. 3. The face width of the friction lining is 50 mm and the coefficient of friction is 0.4. The maximum intensity of pressure on the lining is 0.8 N/mm². The angle \( \theta_1 \) can be assumed to be zero and \( \theta_2 = 90^\circ \). Calculate the actuating force \( P \).
All dimensions in mm.
2015-16
B. E. V SEMESTER EXAMINATION
(Mechanical)
HEAT AND MASS TRANSFER
(EME-323)

Maximum Marks: 60

Answer all questions
The symbols have their usual meaning.
Missing data, if any, may be assumed suitably.

1. With suitable assumptions, obtain the relations for temperature distribution, heat transfer and efficiency of a rectangular fin with heat dissipation from the fin tip in addition to the fin-lateral surface. Also, find expression for the maximum heat dissipation and hence, define fin effectiveness in terms of Biot Number.

OR

1'. Mention some of the practical systems with heat generation. Derive the relation for temperature distribution during 1D steady state conduction in a solid sphere with heat generation. During the ripening process of oranges, the energy released is estimated as 563 W/m³. If the orange is assumed to be homogenous sphere of diameter 8 cm with k=0.15 W/mK, compute temperature at the center of the orange and the heat flow from the outer surface, (a) If the external surface temperature is 2°C. (b) If instead of the external surface temperature, the ambient (h=12 W/m²K) temperature is 2°C.

2(a). Explain free and forced convection, showing the boundary layer formation, variation of velocity and temperature profiles in each case.

2(b). In a certain process, castor oil at 30°C flows past a flat plate. The velocity of the oil is 0.08 m/s. The length of the plate is 5 m. The plate is heated uniformly and maintained at 90°C. Calculate the following:
(i) Velocity and thermal boundary layer thicknesses at the trailing edge of the plate.
(ii) Average heat transfer coefficient and heat transfer rate.
At the mean film temperature T_f = (90+30)/2 = 60°C, thermo-physical properties of oil are: \( \rho = 956.8 \text{ kg/m}^3 \), \( k = 0.213 \text{ W/mK} \), \( \alpha = 7.2 \times 10^{-8} \text{ m}^2/\text{s} \), \( \nu = 0.65 \times 10^{-4} \text{ m}^2/\text{s} \).

OR

Contd.....2.
2. Obtain the expression for Nusselt Number during laminar film condensation over a vertical plane. Indicate the modifications required to use this equation for the vertical and horizontal cylinders and discuss their utility in practical applications.

3(a) Define monochromatic emissivity and total emissive power. Explain Wien’s displacement law and Kirchoff’s law of thermal radiation.

3(b) A hemispherical furnace of radius 1.0 m has the surface temperature of 527 °C and emissivity 0.8. The flat circular cover of the furnace is at 327 °C with emissivity 0.5. Calculate the net heat exchange between the surface of the furnace and the cover.

OR

3'(a) Derive the expressions for surface resistance and space resistance for thermal radiation systems.

3'(b) Two identical circular plates each with area 1 m² and emissivity 0.5 are arranged facing each other in a very large surrounding room at 300 K. The plates are maintained at 853 K and 480 K, respectively. The surfaces of the plates facing each other are radiating heat among themselves and with the room. Assuming the shape factor between the circular plates as 0.6, find the net heat transfer between the two plates and the heat received by the room.

4(a) Define heat exchanger effectiveness and derive its relation for parallel flow heat exchanger in terms of heat capacity ratio and number of transfer units.

4(b) Water enters a parallel flow heat exchanger at 20 °C with a flow rate of 833.33 kg/min. while oil enters at 110 °C with a flow rate of 500 kg/min. The overall heat transfer coefficient is 1000 W/m²K and heat exchanger area is 10 m². Find the exit temperatures of the two fluids, assuming specific heat of water as 4.2 kJ/kg K and that of oil as 3.6 kJ/kg K.

5. Explain Lewis number, Sherwood number and Schmidt number. For a system in which unsaturated air passes over a wet surface and heat & mass transfer take place simultaneously, obtain the relation: \[
\frac{(\omega_s - \omega_w)}{(T_\infty - T_w)} = \frac{C_p}{h_{fg}} \left( \frac{\alpha}{D} \right)^{1/4}
\]
Q.No
1 Consider the superposition of a uniform flow \( U \), a doublet of strength \( \mathbf{k} \). Obtain the stream function, potential function and determine the locations of stagnation streamlines, stagnation points. By applying Bernoulli's equation obtain the coefficient of pressure.

2 Consider flow of fluid contained in between two concentric cylinders (Radius \( R_1 \) and \( R_2 \)) arising from their rotations at angular speeds \( \omega_1 \) and \( \omega_2 \). Using Navier stokes-equations in cylindrical coordinates, obtain the relation for the velocity distribution.

OR

2' Incompressible Newtonian fluid with constant density and viscosity flows between two parallel plates of infinite widths. The upper plate is moving in x-direction with a velocity \( U_0 \). The height between the plates is 'h', Body forces are neglected. The components of the pressure gradient are.

Contd......2.
Starting from Navier-Stokes and applying the order of magnitude analysis, obtain the Prandtl Boundary layer equation for flow over a flat plate.

OR

Derive momentum integral equation

Why is it difficult to obtain the entire details of the turbulent flow.

Estimate the length and time scales for the flow over a flat plate.

Derive the Reynolds Averaged Navier-Stokes equation for incompressible flow. Explain turbulence closure problem.

What is the effect of the wall friction on the flow in a constant area duct in terms of Mach number and pressure.

Explain the effect of heat addition/removal on the flow in a constant area duct. Discuss the Rayleigh line.

A normal shock occurs at a point in an air-flow where the pressure is 30 kPa and the temperature is -30°C. If the pressure ratio across this shock wave is 2.7, find the pressure and temperature downstream this normal shock wave and the velocities both upstream and downstream of the shock wave. Also find the change in the stagnation pressure across the shock.

OR

Contd.....3.
5'(c) A bend in the bottom of a supersonic duct flow induces a shock wave which reflects from the upper wall as shown in Fig. Compute the Mach number and pressure in region 3.

Air:
\( \rho_1 = 100 \text{ kPa} \)
\( M_{a1} = 3.0 \)

10°
Maximum Marks: 60
Credits: 04
Duration: Three Hours

Answer ALL questions. Assume suitable data if missing. Notations used have their usual meaning.

1 (a) Define Industrial Engineering and Productivity. [4]
(b) Explain the various phases of a product life cycle in terms of product volume, variety, and industry structure. Use a suitable example. [8]

2 (a) What is cellular manufacturing? What are the benefits of using this system? [4]
(b) Explain any four major factors that influence facility location decisions. [8]

OR

2' (a) Briefly explain the features of a process layout. [4]
(b) A software development company is planning to conduct a survey of potential customers to whom particular software can be sold. The activities involved in the survey along with their respective durations (in days) are given below (Table-1). Using this information (i) draw a network diagram, (ii) determine the EST, EFT, LST, LFT, and TTF for each activity, and (iii) identify the critical path.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2: Determining survey objectives</td>
<td>2</td>
</tr>
<tr>
<td>2-3: Select and hire personnel</td>
<td>3</td>
</tr>
<tr>
<td>2-4: Design questionnaire</td>
<td>4</td>
</tr>
<tr>
<td>3-5: Train the personnel</td>
<td>5</td>
</tr>
<tr>
<td>4-5: Select target audience</td>
<td>2</td>
</tr>
<tr>
<td>5-6: Conduct the survey</td>
<td>6</td>
</tr>
</tbody>
</table>

(Table-1)

3 (a) Define “capacity” of a manufacturing system. Why is capacity planning important? [4]
(b) Define “method study” and “time study”. What are their objectives? [8]

4 (a) Explain the holding, ordering, and stock-out costs involved in inventory models. [4]
(b) A hospital buys oxygen cylinders from a manufacturer. The unit price (in Rupees) quoted by the manufacturer for a different order size (in units) is as given below.

Contd.....2.
Order quantity & Unit price
1-99 & 50.00 \\
100 to 499 & 45.00 \\
500 and above & 40.00 \\
The annual demand of the cylinders is 2000. The ordering costs are estimated to be Rs 25 per order and the inventory carrying costs are charged at 30 percent. Find the optimal order quantity, its corresponding annual costs of inventory, and the order cycle.

5 (a) Explain the sampling risks in acceptance sampling.

(b) The Martin Company produces plastic bottles to customer order. The quality inspector randomly selects a sample of four bottles from the bottle machine and measures the outside diameter of the bottle neck, a critical quality dimension that determines whether the bottle cap will fit properly. The dimensions (inches) from the last six samples are given in Table-2. Determine the control limits for $\bar{X}$ and R charts, plot the observations on these charts, and comment whether the process is in control or not.

<table>
<thead>
<tr>
<th>Sample</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.604</td>
<td>0.612</td>
<td>0.588</td>
<td>0.600</td>
</tr>
<tr>
<td>2</td>
<td>0.597</td>
<td>0.601</td>
<td>0.607</td>
<td>0.603</td>
</tr>
<tr>
<td>3</td>
<td>0.581</td>
<td>0.570</td>
<td>0.585</td>
<td>0.592</td>
</tr>
<tr>
<td>4</td>
<td>0.620</td>
<td>0.605</td>
<td>0.595</td>
<td>0.588</td>
</tr>
</tbody>
</table>

(Table-2)
Factor for UCL and LCL for $\bar{X}$-chart = 0.729,
Factor for UCL for R-chart = 2.282,
Factor for LCL for R-chart = 0.00.

5'(a) List the assumptions of a linear programming model.

(b) A linear programming problem has been formulated as below in terms of the two variables x and y. Find an optimal solution using the graphical method.
Maximize $z = 8(120x + 100y)$
Subject to: $10x + 5y \leq 80$, $6x + 6y \leq 66$
           $4x + 8y \geq 24$, $5x + 6y \leq 90$,
           and $x, y \geq 0$. 

OR

A linear programming problem has been formulated as below in terms of the two variables x and y. Find an optimal solution using the graphical method.
Maximize $z = 8(120x + 100y)$
Subject to: $10x + 5y \leq 80$, $6x + 6y \leq 66$
           $4x + 8y \geq 24$, $5x + 6y \leq 90$,
           and $x, y \geq 0$.