1. Answer any THREE parts of the following:
   (a) Find a real root of the equation \( x^3 + x^2 - 100 = 0 \) by general iteration method. Take \( x_0 = 4.2 \) and perform three iterations.
   (b) Derive a Newton-Raphson iteration formula for finding the cube root of a positive number \( C \). Hence find cube root of 12 using three iterations.
   (c) Solve the following equations by Gauss-Seidel iteration method:
       \[ 6x + 15y + 2z = 72, \quad 27x + 6y - z = 85 \text{ and } x + y - 54z = 110. \]
       Give only three iterations.
   (d) (i) Solve by Gauss-elimination method the equations:
       \[ 2x + y + 4z = 12, \quad 8x - 3y + 2z = 20 \text{ and } 4x + 11y - z = 33. \]
       (ii) Show that the following sequence
       \[ x_{n+1} = \frac{1}{8} x_n \left( 6 + \frac{3a}{x_n^2} - \frac{x_n^2}{a} \right) \]
       has convergence of third-order with the limit \( \sqrt[3]{a} \).

2. Answer any THREE parts of the following:
   (a) Using Newton’s divided difference formula find (i) \( f(5) \), (ii) \( f'(6) \) and
   (iii) \( \int f(x) \, dx \) from the following data:
       \[
       \begin{array}{cccccc}
       x & 0 & 2 & 3 & 4 & 7 \\
       f(x) & 4 & 26 & 58 & 112 & 466 & 922 \\
       \end{array}
       \]
   (b) (i) Using Newton’s forward difference formula, find the polynomial which passes through the points \( (0, 3), (2, -3), (4, -1) \), \( (6, 9), (8, 27) \) and \( (10, 53) \).
   (ii) Prove the following with the usual notation:
       \[ \mu = \sqrt{1 + \frac{1}{4} \delta^2} \]
   (c) The velocities of a car (running on a straight road) at intervals of 2 minutes are given below:
       \[
       \begin{array}{cccccc}
       \text{Time in minutes} & 0 & 2 & 4 & 6 & 8 & 10 & 12 \\
       \text{Velocity in Km/hr} & 0 & 22 & 30 & 27 & 18 & 7 & 0 \\
       \end{array}
       \]
       Apply Simpson’s rule to find the distance covered by the car in 12 minutes and also the acceleration at \( t = 2 \) minutes.
(d) Determine a, b and c such that the quadrature formula
\[ \int_0^h f(x) \, dx = h \left[ a f(0) + b f \left( \frac{h}{3} \right) + c f(h) \right] \]
is exact for polynomials of as high order as possible.

3. Answer any THREE parts of the following:

(a) From the Taylor series for \( y(x) \), find \( y(0.1) \) correct to four decimal places if \( y(x) \) satisfies \( \frac{dy}{dx} = x - y^2 \) and \( y(0) = 1 \).

(b) Using Modified Euler's method, find the value of \( y \) when \( x = 0.1 \) given that \( y(0) = 1 \) and \( \frac{dy}{dx} = x^2 + y \). Take \( h = 0.1 \) and give only two iterations.

(c) Apply the fourth order Runge-Kutta method, to find an approximate value of \( y \) when \( x = 0.2 \) given that \( \frac{dy}{dx} = 1 + y^2 \), \( y(0) = 0 \). Take \( h = 0.2 \).

(d) Using finite difference method, solve the boundary value problem \[ \frac{d^2y}{dx^2} + y + 1 = 0 \] with \( y(0) = y(1) = 0 \). Compute the value of \( y(0.5) \). Take \( h = \frac{1}{4} \).

4. (a) A furniture manufacturing company plans to make two products: chairs and tables from its available resources, which consists of 400 board feet of mahogany timber and 450 man-hours. It knows that, to make a chair requires 5 board feet and 10 man-hours and yields a profit of Rs.45; while each table uses 20 board feet and 15 man-hours and has a profit of Rs.80. The problem is to determine how many chairs and tables the company can make, keeping within its resource constraints so that it maximizes its profits. Setup a LPP to maximize profit.

OR

(a) Solve graphically \( \text{Max } Z = 6x_1 + 15x_2 \)
subject to \( 5x_1 + 3x_2 \leq 15 \), \( 2x_1 + 5x_2 \leq 10 \), \( x_1, x_2 \geq 0 \).

(b) Solve the following LPP by Simplex method
Maximise \( Z = 6x_1 + 9x_2 \) subject to the constraints \( 2x_1 + 2x_2 \leq 24 \), \( x_1 + 5x_2 \leq 44 \), \( 6x_1 + 2x_2 \leq 60 \), \( x_1, x_2 \geq 0 \).

(c) Find the dual of the following LPP:
Maximise \( Z = 3x_1 + 5x_2 + 3x_3 \) subject to \( 2x_1 - x_2 + 3x_3 \leq 6 \), \( x_1 + 2x_2 + 4x_3 \leq 8 \), \( x_1, x_2, x_3 \geq 0 \).
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) | Define the term kinematic chain. For a kinematic chain what is the relation between number of pairs and number of links. Write the equation showing the relation between number of links and number of joints. | [03]
1(b) | Differentiate between
i) Completely constrained motion and incompletely constrained motion
ii) Binary joints and binary links
iii) Structure and a machine | [03]
1(c) | What do you mean by straight line mechanism? Explain the Peaucellier Mechanism which is used for exact straight line motion. | [06]

OR
1(c') | Describe with a neat sketch the working of Davis Steering Mechanism. Prove that for Davis steering gear,

\[
\tan \alpha = \frac{w}{2L}; \text{ where } w, \alpha \text{ and } L \text{ are having their usual meaning.}
\] | [06]

2 | The crank of a slider crank mechanism is 150mm and the connecting rod is 600mm long. The crank makes 300 rpm in the clockwise direction. When it has turned 45 degrees from the inner dead position, determine; i) linear velocity and acceleration at the mid-point of the connecting rod and ii) angular velocity and angular | [12]
acceleration of the connecting rod.

OR

2' The length of the crank and connecting rod of a reciprocating engine are 200mm and 800 mm respectively. The crank is rotating at a uniform speed of 480 rpm. Using Klein's construction find i) the acceleration of the piston ii) the acceleration of the middle point of the connecting rod, and iii) angular acceleration of the connecting rod when the crank has turned through 45° from the inner dead centre in clockwise direction.

3 Determine the length of a four bar linkage to generate \( y = \log_{10} x \) in the interval \( 0 \leq x \leq 10 \). The length of the smallest link is 5 cm. Use three accuracy points with Chebyshev's spacing.

4(a) Calculate: i) Length of path of contact, ii) arc of contact and iii) the contact ratio when a pinion having 23 teeth drives a gear having 57 teeth. The profile of the gear is involute with pressure angle 20°, module 8 mm and addendum equals to one module.

4(b) A pair of spur gear with involute teeth is to give a gear ratio of 4:1. The arc of approach is not to be less than the circular pitch and the smaller wheel is the driver. The angle of pressure is \( 14 \frac{1}{2} \). Determine the least number of teeth that can be used on each wheel.

OR

4'(a) Explain the working principle of any two of the following with neat sketches:

i) Differential gear  ii) reverted gears  iii) Epicyclic gear train.
4'(b) Two parallel shafts are connected with the help of two gears one on each shaft. The number of teeth on one gear is 38 and the speed of the shaft is 420 rpm. If the speed ratio is equal to 3 and circular pitch of the gear is 25 mm then find i) number of teeth and speed of other shaft ii) Centre distance between two shafts

(5) Draw the profile of a cam operating a knife edge follower for the following data:

i) Follower to move outward through 30 mm with simple harmonic motion during 120° of cam rotation
ii) Follower to dwell for next 60 degrees
iii) Follower to return to its original position with uniform velocity during 90° of cam rotation
iv) Follower to dwell for the rest of cam rotation

The least radius of the cam is 20 mm and the cam rotates at 240 rpm. Also determine the maximum velocity and maximum acceleration of the follower during outstroke.
1(a) Determine the driving moment on link 2 of the mechanism shown in Fig. 1 by graphical method. Also find out the force transmitted to the foundation and show their directions.

1(b) Figure 3 and 4 represent the velocity and acceleration diagrams, respectively, for the mechanism shown in Fig. 2. Draw free body diagrams of the different links of the mechanism showing directions of inertia forces, inertia torque, angular acceleration and acceleration of the C.G. of the link.

Need not to draw configuration, velocity and acceleration diagrams

OR

1' Make a complete inertia force analysis of the reciprocating engine mechanism shown in figure 5 using the following data.
Length of crank = 7.5 cm, Length of connecting rod = 28 cm
Distance of C.G. of link 2 from main bearing = 5 cm
Distance of C.G. of link 3 from crank pin bearing = 12 cm
Crank makes an angle 0 with the line stroke = 60°
Crank speed = 2000 rpm (CCW)
Mass of link 2 = 2.5 kg, Mass of link 3 = 4 kg, Mass of link 4 = 3 kg
Mass moment of inertia of link 2 = 60 kg cm²
Mass moment of inertia of link 3 = 500 kg cm²

2(a) The equation of a turning moment curve of an IC engine running at 300 rpm is given by $T = (25000 + 8500 \sin 3\theta)$ Nm about the axis of rotation. Determine
(i) Power of engine
(ii) Total percentage fluctuation of speed
(iii) Maximum angle by which the flywheel leads or lags an imaginary flywheel running at a constant speed of 300 rpm.

Contd......2
2(b) Define the piston effort and crank effort. Also explain dynamically equivalent system.

3(a) Find the magnitudes of the unbalance primary and secondary forces in V-engine. Deduce the expression when the times of stroke of two cylinders are set at 60° to each other.

3(b) The three cylinder radial engine driven by a common crank has the cylinders spaced at 120°. The stroke is 100 mm, length of the connecting rod 200 mm and the reciprocating mass per cylinder 1.5 kg. Calculate the primary and the secondary forces at crank speed of 1500 rpm.

OR

3(b') Four masses m1, m2, m3 and m4 are rigidly attached to a rotating shaft as per the detail shown in figure 6. Determine the balancing mass and its angular and axial position on the shaft graphically.

4(a) Each ball of a Porter governor has a mass of 6 kg and the sleeve weighs 18 kg. Each arm is of 300 mm length. The radius of rotation of the ball is 200 mm when the governor begins to lift and 250 mm when the speed is maximum. Determine the maximum and minimum speed and the range of speed of the governor.

4(b) What is the function of a governor and how does it differ from that of a flywheel? Describe the working principle of a centrifugal governor with suitable diagram.

5(a) A motor cycle along with the driver and pillion rider have a mass of 300 kg and the system centre of gravity is 60 cm above the ground level. Each wheel of the machine has a mass of 10 kg, radius of 30 cm and radius of gyration of 25 cm. The rotating parts of the engine have equivalent mass of 15 kg and radius of gyration of 8 cm and they rotate in the same sense as road wheels. The gear ratio from road to wheel is 1:8. Calculate the angle of banking necessary for the machine to ride normal to the banked track on a bend of 80 m radius at a speed of 150 km/hr.

5(b) A rear engine automobile is travelling along a curved track of 120 m radius. Each of the four wheels has a moment of inertia of 2.2 kgm². The gear ratio of the engine to the back wheel is 3.2. The engine axis is parallel to rear axle and the crankshaft rotates in the same sense as the road wheels. The mass of vehicle is 2050 kg and the centre of mass is 520 mm above the ground. The width of the track is 1.6 m. What will be the limiting speed of the vehicle if all the four wheels maintain contact with the road surface?

FIGURE ENCLOSED

Contd.……..3
Fig. 1

\[ \text{O}_1A = 100 \text{ cm} \]
\[ \text{AB} = 32 \text{ cm} \]

Fig. 2

\[ \omega_2 = 1200 \text{ rpm} \text{ Constant} \]

Fig. 3

Velocity diagram

Fig. 4

Acceleration diagram

Fig. 5

Fig. 6

\[ C360 \text{ kg} (m_1) \]
\[ B450 \text{ kg} (m_2) \]
\[ 300 \text{ kg} (m_3) \]
\[ 390 \text{ kg} (m_4) \]
2013-14
B.TECH. (AUTUMN SEMESTER) EXAMINATION
MECHANICAL ENGINEERING
MACHINE DESIGN - II/ MACHINE DESIGN
ME-316/317

Maximum Marks: 60  Credits: 04  Duration: Three Hours

Answer any five questions.
Assume suitable data if missing.
Use tables and charts as given with the question paper.

Q.No.  Questions

1
(a) What are the advantages of welded joints over riveted joints? Also explain the limitations of welded joints.[4]

(b) Determine the size of the fillet weld required for the plate loaded as shown in Fig. 1 for an allowable stress of 100MN/m².[8]

2
(a) Differentiate between boundary lubrication, mixed lubrication and thick film lubrication.[4]

(b) The shaft shown in Fig. 2 has parallel belt pulls with tension on the loose side of pulley 4 being 30 percent of the tension on the tight side. The shaft rotates at 900rpm. Tapered roller bearings are to be mounted in housings at O and B. The bearings are to have reliability of 99 percent corresponding to a life of 36 Khrs. Determine dynamic load capacity for bearings at O and B.[8]

3
(a) Explain in brief the Band-Shoe brake with a neat sketch. Derive the equation for actuating force for the clockwise rotation of the drum in terms of co-efficient of friction $\mu$ between drum and shoe.[3]

(b) Drive the expression for pressure variation in the external long shoe block brake. Clearly state the assumption made in the derivation.[3]

(c) Fig. 3 shows a single long shoe drum brake. Find its torque capacity and required actuating force. Also find the reaction forces at the arm pivot in global XY system for the brake and rate of heat generation if drum rotates at 125rpm.
Take: $a_x = 100mm$, $b_x = 70mm$, $b_y = 20mm$, $r = 30mm$, $w = 50mm$, $\theta_1 = 25^\circ$, $\theta_2 = 125^\circ$, $P_{max} = 1.3MPa$ and $\mu = 0.3$.[6]

Contd.......2
3) a) The semi-cone angle of a cone clutch is 12.5° and the contact surface has mean diameter of 80mm. Co-efficient of friction is 0.32. What is the minimum torque required to produce slipping of the clutch for an axial load of 200N? If the clutch is used to connect an electric motor running at 900rpm, to a stationary flywheel, what is the time needed to attain the full speed and the energy lost in slipping. The moment of inertia of the flywheel is 0.4 kg·m².

b) Explain, in brief, the function of centrifugal clutch with the help of neat sketch.

4) a) Design a helical valve spring made of oil hardened and tempered spring wire for an operating range of 100N to 150N. The deflection of the spring under maximum load is 22.5mm. The desired factor of safety is 1.5. Take ultimate tensile strength of the spring material 1556MPa, modulus of rigidity=80GPa and spring index=6.

b) Why do we consider nipping in the leaf spring. Suggest alternative solutions to the nipping. Derive the expression for initial pre-load P, required to close the nip in terms of maximum working load P for which leaf spring is designed.

5) a) Power is being transmitted through a pair of spur gears, hence derive the expression of induced contact stress.

b) A18 tooth pinion is to drive a 30 tooth gear with a centre distance of 96mm. The face width is 50 mm and teeth are 20 full depth with a dedendum of 1.25 module. The pinion speed is 1150rpm and 7.5 kW is to be transmitted under steady load conditions. The material selected for both the gears is a forged BS826M40 steel heat treated to a hardness of 302 Bhn. Determine the factor of safety with 90 percent reliability, better than average mounting conditions and cutting accuracy. Take elastic coefficient $C_p=191\sqrt{MPa}$.

5') a) Power is transmitted through a pair of helical gears. The total tooth force is $P_n$, derive the components of total force.

b) A pair of helical gears is transmitting 15kW power at a pinion speed of 1440rpm, normal module is 5mm, number of teeth on pinion is 18 and the gear ratio is 3. The normal pressure angle and transverse pressure angle are 20° and 20°-15° respectively. Both gears are made of steel heat treated to 300Bhn. Determine the factor of safety guarding against surface durability with reliability 99.9 percent, uniform power, moderate shock and accurate mounting conditions. Take face width 12.5 times transverse module and elastic coefficient $C_p=191\sqrt{MPa}$.

FIGURES ENCLOSED

Contd......3
**Fig. 1**

**Fig. 2**

All dimensions are in mm

**Fig. 3:** Geometry for a long-shoe external drum brake.

**LIFE AND RELIABILITY MODIFICATION FACTORS**

<table>
<thead>
<tr>
<th>Cycles of Life</th>
<th>Life Factor</th>
<th>Reliability</th>
<th>Reliability Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10^6$</td>
<td>1.5</td>
<td>Up to 0.99</td>
<td>0.80</td>
</tr>
<tr>
<td>$10^7$</td>
<td>1.3</td>
<td>0.99 to 0.999</td>
<td>1.00</td>
</tr>
<tr>
<td>$10^8$</td>
<td>1.1</td>
<td>0.999 up</td>
<td>1.25 up</td>
</tr>
<tr>
<td>$10^9$ up</td>
<td>1.0</td>
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<td></td>
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</tbody>
</table>

**OVERLOAD CORRECTION FACTOR**

<table>
<thead>
<tr>
<th>Source of Power</th>
<th>Driven machinery</th>
<th>Uniform</th>
<th>Moderate shock</th>
<th>Heavy shock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uniform</td>
<td>Uniform</td>
<td>1.00</td>
<td>1.25</td>
<td>1.75</td>
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<tr>
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<td>Uniform</td>
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<td>Medium shock</td>
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<td>1.75</td>
<td>2.25</td>
</tr>
</tbody>
</table>

**DAD DISTRIBUTION FACTORS**

<table>
<thead>
<tr>
<th>Characteristics of Supports</th>
<th>Face width, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-50</td>
</tr>
</tbody>
</table>
| Accurate mounting, small bearing clearance, minimum deflection, 
  precise gears              | 1.2  | 1.3 | 1.4  | 1.7     |
| Less rigid mountings, less 
  accurate gears, contact across full face | 1.5  | 1.6 | 1.7  | 2.0     |
| Accuracy and mounting such 
  that less than full face contact exits | Over 2.0 |
2013-2014

B. TECH. AUTUMN (V SEMESTER) EXAMINATION
(MECHANICAL ENGINEERING)
HEAT AND MASS TRANSFER
ME-323
Credits-04

Maximum Marks: 60

Duration: Three Hours

(i) Answer all questions.
(ii) The symbols have their usual notations.
(iii) Use of property table is permitted.
(iv) Assume suitable data if required.

1. Showing the heat transfer rates on an elemental volume, derive the generalized heat conduction equation for a cylindrical body and hence, obtain the Poisson’s, Fourier’s and Laplace equations. [12]

OR

1’s(a). Explain the importance of transient heat conduction. What is a Lumped heat Capacity system. Derive an expression for temperature-time response of a thermocouple and find the relation for its time constant. [06]

1’s(b). A carbon steel rod, 0.2 m long and 0.06m diameter, is quenched from 500°C to 30°C in a large reservoir of water at 10°C. Below 100°C, the heat transfer coefficient is 300 W/m²K and above 100°C, its effective mean value is 100 W/m²K. The thermo physical properties of Carbon steel are \( \rho = 7854 \text{ kg/m}^3 \), \( k = 50 \text{ W/mK} \), \( C = 559 \text{ J/kgK} \). Neglecting the internal thermal resistance, calculate the quenching time. [06]

2(a). With neat sketch, explain the velocity and temperature boundary layers over a plane surface during forced and free convection. [06]

2(b). A liquid metal flows at the rate of 4 kg/s through a 60 mm diameter tube in a nuclear reactor. The fluid enters at 200°C as it passes through the tube. If a constant heat flux is maintained along the tube wall, which is at a temperature 40°C higher than the fluid temperature, calculate the length of the tube required for 25°C rise in bulk fluid temperature. The relation for heat transfer at constant heat flux condition is: \( N_u = 0.625 \left( \frac{RePr}{P} \right)^{0.4} \). Properties of the liquid metal are: \( \rho = 7700 \text{ kg/m}^3 \), \( \mu = 0.616 \times 10^{-3} \text{ kg/m-s} \), \( C_p = 0.13 \text{ kJ/kgK} \), \( k = 12 \text{ W/mK} \). [06]

OR


2’s. Differentiate between filmwise and dropwise condensation. With suitable assumptions, obtain the relation for average heat transfer coefficient during film condensation over a cooled vertical surface. In a condenser, which orientation of the tubes, whether horizontal or vertical, will give higher value of the heat transfer coefficient? [12]

3(a). Describe the purpose and applications of radiation shield. Using the electrical network analogy, derive the general equation for radiation exchange between two non-black bodies. [07]
3(b). Calculate the net radiation exchange between two square plane surfaces of 6m² area separated by a gap of 5mm. One of the surfaces is at a temperature of 1000K having emissivity 0.8 while the other, is at a temperature of 350K and emissivity 0.95. If a thin polished metal sheet of surface emissivity 0.1 on both sides is inserted between these planes, calculate the steady state temperature of the metal sheet, the new net radiation exchange between the planes and the percentage reduction in the heat exchange by radiation.

OR

3'. Based upon the statistical thermodynamics the relation for monochromatic emissive power, \( E_{bh} = \frac{2\pi hC^2\lambda^{-5}}{[e^{\frac{hC}{kT}} - 1]} \), where, \( C = 3 \times 10^8 \text{ m/s} \) (speed of light), \( h = 6.625 \times 10^{-34} \text{ J.s} \) (Plank's constant), \( T = \text{Temperature in Kelvin} \), \( k = 1.38066 \times 10^{-23} \text{ J/K} \) (Boltzman Constant) and \( \lambda = \text{Wavelength in m} \).

Explain Planck's distribution and Wein's displacement laws. Estimate approximate temperature of the sun, if the maximum radiation entering the earth's atmosphere is 0.5 μm. Also, discuss the effect of change in wavelength with increase in temperature of emitting surface.

4(a) Define heat exchanger effectiveness and obtain relation for effectiveness of the counter flow condition. Discuss the two limiting cases of interest.

4(b) A chemical of specific heat 3.6 kJ/kg°C is flowing at a rate of 8.3 kg/s, enters a parallel flow heat exchanger at 100 °C. The cooling water is circulated at the rate of 13.9 kg/s for the purpose of cooling the chemical. The inlet temperature of water is 10 °C. The effective heat transfer area of the exchanger is 10 m² and \( U=1.163 \text{ kW/m²°C} \). Find the outlet temperatures of water and chemical, effectiveness of heat exchanger, and maximum drop in temperature of hot fluid possible with parallel flow arrangement.

5(a) Explain diffusion and convective mass transfers. Also, show that they are respectively analogous to the conduction and convective heat transfers.

5(b) Pure water at 22°C (\( D = 1.29 \times 10^{-9} \text{ m²/s} \); \( \rho=1000 \text{ kg/m}^3 \), \( \nu=1.006 \times 10^{-6} \text{ m²/s} \)) flows over a slab of salt at a velocity of 2m/s. At the interface the concentration of salt is 400kg/m³. Determine over a length of 1.5 m the average convection coefficient for mass transfer and also the rate of diffusion of salt into water. The relation for mass transfer is \( Sh = 0.0228 \text{ Re}^{0.8} \text{ Sc}^{0.337} \).
2013-14
B.TECH. (AUTUMN SEMESTER) EXAMINATION
(MECHANICAL ENGINEERING)
I.C. ENGINES
ME-324

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 Scavenging process in IC engines. Discuss different systems and types of scavenging. Draw neat sketches. [06]
1(b) An un-supercharged engine develops a gross IMEP of 10 bar when running on a mixture strength of 20% richer than chemically correct mixture. The pumping IMEP being 0.34 bar. The charge pressure and temperature being 0.94 bar and 100 °C respectively. The mean pressure during induction is 0.9 bar. When this engine is supercharged by a centrifugal blower of adiabatic efficiency of 70%. The temperature after the blower is raised by 50 °C and pressure (loss) after the blower is 0.06 bar. The charge pressure in the cylinder being 1.3 bar. Estimate the percentage increase in net IMEP due to supercharging. Assume \( k = 1.4 \), \( p_{atm} = 1 \) bar, \( T_{atm} = 15 \) °C. [06]

OR

1'(a) Discuss the air fuel ratio requirements of a petrol engine from no load to full load under steady state operation. [5]
1'(b) The average indicated power developed in a CI engine is 12.9 kW/m³ of free air inducted per minute. The engine is 3 litre, 4-stroke running at 3500 rpm and has a volumetric efficiency of 80% referred to free air conditions of 1.013 bar and 15 °C. It is proposed to fit a blower driven mechanically from the engine. The blower has [7]

Contd......2
an isentropic efficiency of 75 % and works through a pressure ratio of 1.7. Assume
that at the end of induction, the cylinder contains a volume of charge equal to the
swept volume at delivery conditions from the blower. Calculate the increase in
brake power of the engine. Assume all mechanical efficiencies as 80 %

2(a) How does a real cycle differ from a fuel-air cycle? Describe various losses
encountered in actual cycles.

2(b) An engine working on Otto cycle having compression ratio 7, uses hexane (C₆H₁₄)
as fuel. The calorific value of the fuel is 43890 kJ/kg. The air fuel ratio of the
mixture is 13.67: 1. Determine the maximum pressure and temperature reached in
the cycle; (i) without considering the molecular contraction (ii) considering the
molecular contraction.

Take Cv = 0.71 kJ/kgK, Compression follows the law Pν¹/³ = constant.
Pressure and temperature at the beginning of compression are 1 bar and 67°C
respectively.

OR

2'(a) What do you understand by Equilibrium charts of combustion. Discuss Unburned
and Burned mixture charts, highlighting the assumptions made in each case.

2'(b) If the specific heats of a gas are expressed as Cp = a + kT and Cv = b + kT, where
a, b & k are arbitrary constants.
Prove that the law of adiabatic expansion is given by \( p^b \nu^a e^{kT} = \text{const} \).

3(a) Differentiate between knocking phenomena in SI and CI engines.

3(b) Explain the combustion phenomenon in case of SI engines. Indicate different
phases of combustion on p ~ θ diagram.

4(a) Explain the advantages of Regeneration in a Gas Turbine Plant. Obtain the
expression for Thermal efficiency of such a plant taking into account all component
efficiencies.

4(b) A turbojet aircraft flies with a velocity of 260 m/s at an altitude where the air is at
35 kPa and -40 °C. The compressor has a pressure ratio of 10 and the temperature
of gases at the turbine inlet is 1100 °C. Air enters the compressor at a rate of 45 kg/s
Assuming steady operating conditions with constant specific heats, determine

Contd........3
(i) the temperature and pressure of the gases at the turbine exit
(ii) the velocity of the gases at the nozzle exit
(iii) propulsive efficiency of the cycle

OR

47(a) Explain the working principle and main characteristics of a Turbojet engine. Compare its performance with Turboprop engine.

47(b) Consider an ideal gas turbine cycle with two stages of compression and two stages of expansion. The pressure ratio across each stage of compressor and turbine is 3. The air enters each stage of compression at 300 K and each stage of expansion at 1200 K. Determine the ratio of the compressor work to the turbine work (i.e. back work ratio) and the thermal efficiency of the cycle assuming (i) no regenerator is used (ii) a regenerator of 75% effectiveness is used.

5(a) Describe the ASTM distillation curve for gasoline. Discuss the effect of different volatility ranges on engine performance.

5(b) Define 'Cetane Number'. Give the procedure and test conditions for the determination of Cetane number of a CI engine fuel.
Q. No. 1(a) For the figure shown below, find the resultant velocity vector at point P due to the uniform flow, clockwise line vortex (strength = 120 m²/s) at point B and a line source (strength = 80 m²/s) at point A.

\[ \text{Uo} = 10 \text{ m/s} \]

Q. No. 1(b) Consider air (density = 1.2 kg / m³) flowing at 30 m/s past a 1m diameter circular cylinder as shown in figure below. Estimate:

(i) the strength of the doublet located at the center of the cylinder required to simulate the potential flow past the cylinder.

(ii) the circulation (magnitude and sense) that must be provided to the flow to locate the stagnation point at the top shoulder (point A) of the cylinder.
(iii) the sideways force (magnitude and direction) per unit length of the cylinder corresponding to the circulation in part (ii).

2(a) Air flows over a plane wall at a Mach number of 3.5, the pressure and temperature in the flow being 100 kPa and 18°C, respectively. The wall turns through an angle leading to the formation of an oblique shock wave. If the pressure downstream of the shock is 548 kPa, find the turning angle of the corner and the downstream temperature. What is the maximum permissible turning angle for the formation of an oblique shock wave for the given conditions. \((\gamma = 1.4, C_p = 1.004 \text{ kJ/kg})\)

2(b) Air is expanded from a large reservoir in which the pressure and temperature are 200 kPa and 30°C respectively through a short convergent nozzle which gives an exit Mach number of 0.2. The air then flows down a pipe with a diameter of 25 mm, the Mach number at the end of the pipe being 0.8. Assuming isentropic flow in the nozzle and adiabatic flow in the pipe, find the length of the pipe and the pressure and temperature at pipe exit. Take \(f = 0.005\). \((\gamma = 1.4, C_p = 1.004 \text{ kJ/kg})\)

OR

2'(a) Find the pressure ratio \(p_3/p_1\) and the temperature ratio \(T_3/T_1\) for the flow configuration shown in figure below.

2'(b) Air at a temperature of 100°C with a pressure of 150 kPa enters a constant area duct (area = 8 cm²) at a velocity 200 m/s. Neglecting effects of friction, determine:
(i) The maximum amount of heat that can be transferred to the air flow per unit mass of air and corresponding exit temperature.

(ii) The maximum temperature achievable by heat transfer and the corresponding amount of heat transfer in kW for the given inlet conditions. (γ = 1.4, C_p = 1.004 kJ/kg)

3(a) Why are turbulent flows not predictable in detail?

3(b) Giving a suitable example, explain how the largest and the smallest length and time scales in a turbulent flow can be estimated.

3(c) Consider the momentum equations in Cartesian coordinates for an incompressible, isothermal turbulent flow expressed as,

\[ \rho_o \left[ \frac{\partial u_i}{\partial t} + \frac{\partial u_i u_j}{\partial x_j} \right] = \frac{\partial P}{\partial x_j} + B_i \quad i=1,2,3 \quad j=1,2,3 \]

Apply Reynolds's decomposition and time averaging to the momentum equations to obtain the momentum equations for the mean flow. How many additional unknowns are introduced in the momentum equations for the mean flow.

4(a) (i) Using Navier-Stokes Equations in 2-D flow, obtain non-dimensional form of these equations and explain Reynold's Similarity Principle from the transformed equations.

(ii) Use the following form of the Navier-Stokes equations given below for flow with rotational symmetry and derive the governing equation (given below) for stagnation flow in three-dimensional axisymmetrical case and provide the relevant boundary conditions:

\[ u \frac{\partial u}{\partial r} + w \frac{\partial u}{\partial z} = -\frac{1}{\rho} \frac{\partial p}{\partial r} + \nu \left( \frac{\partial^2 u}{\partial r^2} + \frac{1}{r} \frac{\partial u}{\partial r} + \frac{\partial^2 u}{\partial z^2} \right) \]

\[ u \frac{\partial w}{\partial r} + w \frac{\partial w}{\partial z} = -\frac{1}{\rho} \frac{\partial p}{\partial z} + \nu \left( \frac{\partial^2 w}{\partial r^2} + \frac{1}{r} \frac{\partial w}{\partial r} + \frac{\partial^2 w}{\partial z^2} \right) \]

\[ \frac{\partial u}{\partial r} + \frac{u}{r} + \frac{\partial w}{\partial z} = 0 \]

Contd......4
\[ \phi'' + 2\phi'' - (\phi')^2 + 1 = 0 \]

Take: \( U = ar; \ W = -2az; \ u = xf'(z); \ w = -2f(z); \ \eta = \sqrt{\frac{a}{y}} \ z; \ f(z) = \sqrt{a\nu} \ \phi(\eta) \)

OR

4(a') (i) Obtain the following equation for u-velocity for the viscous flow of a fluid contained between two parallel plates, \( h \) distance apart, with the lower plate fixed and the upper plate moving with a constant velocity \( U_o \) parallel to the plate:

\[ u = (y/h) \ U_o - h^2/(2 \mu) \ (dp/dx) \ y/h \ (1 - y/h) \]

(ii) For the above case find the value of the pressure gradient for zero flow rate between the two plates when the upper plate moves with 20 m/s and the separation between the plates is 5 cm. Take viscosity of the fluid, \( \mu = 6.0 \times 10^{-3} \text{ kg/ms} \).

4(b) Obtain the governing equation of motion of a fluid near a suddenly moving plane surface (Stokes’s first problem). Using appropriate transformation, change the equation into an ordinary differential equation (ODE) and obtain the solution in the following form:

\[ u = U_o \left[ 1 - \left( \frac{2}{\sqrt{\pi}} \right) \int_0^n \exp(-\eta^2) d\eta \right] \]

5(a) Explain the mechanism of separation of boundary layer for flow over a solid surface with the help of the profiles of \( u, \ \partial u/\partial y \) and \( \partial^2 u/\partial^2 y \) inside the boundary layer. What happens to the u-velocity gradient at the point of separation?
5(b)  (i) For the flow between two parallel plates in the entrance region shown in the figure below, obtain the following expression for the length of the inlet zone \( L_i \):

\[
L_i = \frac{5}{4} \left( \frac{Re_{it}}{Re} \right) h
\]

Here \( Re \) is the Reynolds number based on the uniform velocity \( U_0 \) entering the duct and the duct spacing \( (Re=\rho U_0 2h/\mu) \), \( Re_{it} \) is the Reynolds number defined based on length of the inlet zone \( (Re_{it}=\rho U_{in} d/\mu) \) and \( U_{in} \) is the velocity within the potential core. Use the following approximate velocity profile in the boundary layer over the top and bottom plates:

\[
u/U_{in} = \frac{3}{2} \left( \frac{y}{\delta} \right) - \frac{1}{2} \left( \frac{y}{\delta} \right)^3
\]

(ii) For the above case prove that within the potential core the pressure gradient is negative and there is no possibility of separation of boundary layers on either of the two plates.

OR

5(b')  Von-Karman's Momentum-Integral Equation for the boundary layer flow over a surface is given by:

\[
d(U_{in}^2 \delta_2)/dx + \delta_1 U_{in} dU_{in}/dx = \tau_{e}/\rho
\]

Using the above equation obtain an approximate velocity profile in the boundary layer over a flat plate at zero angle of incidence in the form given below:

\[
u = A_1 + A_2 \sin(A_3 y)
\]

Find also the displacement thickness \( \delta_1 \) and skin friction coefficient \( C_f \) and compare these values with the exact solution of Blasius \((\delta_1/x = 1.7208/\sqrt{Re_{x}}, C_f = 0.664/\sqrt{Re_{x}})\).
2013-14
B.TECH (AUTUMN SEMESTER) EXAMINATION
ECONOMICS AND MANAGEMENT
ME 340

Maximum Marks: 60 Credits: 04 Duration: Three Hours

Answer all the questions.
Assume suitable data if missing.

1. a. Describe the differences between consumer and producer goods/services. Why is it more difficult to estimate the demand for producer goods? 03
   b. With the help of suitable examples explain the difference between monopoly and oligopoly. 03
   c. Eight years ago, a large capacity truck was purchased for Rs. 115,000 to provide short haul earthmoving services. The company sold it today for Rs. 45,000. Operating and maintenance cost averaged Rs. 10,500 per year. A complete overhaul at the end of year 4 cost an extra Rs. 3600. Calculate the present worth of the truck at 8% per year compounded quarterly. 06

OR

1’. a. What are economic indicators? Name some and discuss any one of them in detail. 06
   b. For the cash flow shown, determine the present worth, if the interest rate is 12% per year 06

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
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<td>130</td>
<td>130</td>
<td>130</td>
<td>130</td>
<td>160</td>
<td>190</td>
<td>220</td>
<td>250</td>
<td>280</td>
<td>310</td>
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2. a. Differentiate between
    i. Physical depreciation and functional depreciation
    ii. Book value and market value
    An asset that is depreciated over a 5 year period by straight line method has a book value of Rs. 62,000 in year 3 with a depreciation charge of Rs. 26,000 per year. Determine the first cost of the asset and the assumed salvage value. 06

OR

a’. Two alternatives shown are under consideration for improving the security of an organisation. Determine which one should be selected on the basis of a B/C analysis, an interest rate of 7% and a 10 year study period. 06

Contd.......2
Extra Camera New Sensor

<table>
<thead>
<tr>
<th></th>
<th>First Cost (Rs.)</th>
<th>Annual operation &amp; maintenance (Rs./year)</th>
<th>Benefits (Rs./year)</th>
<th>Disbenefits (Rs./year)</th>
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<tr>
<td></td>
<td>38000</td>
<td>49000</td>
<td>110,000</td>
<td>26000</td>
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<tr>
<td></td>
<td>87000</td>
<td>64000</td>
<td>160,000</td>
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</tbody>
</table>

b. Compare the following two alternatives for an interest rate of 10% pa.

<table>
<thead>
<tr>
<th></th>
<th>Alternative 1</th>
<th>Alternative 2</th>
</tr>
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<tbody>
<tr>
<td>First cost (Rs.)</td>
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</tr>
<tr>
<td>Annual cost (Rs./year)</td>
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<td>2500</td>
</tr>
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<td>Salvage Value (Rs.)</td>
<td>3000</td>
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<tr>
<td>Life, years</td>
<td>3</td>
<td>∞</td>
</tr>
</tbody>
</table>

3. a. Differentiate between top managers, middle managers and first line managers.

b. What are the advantages and limitations of group decision making? Differentiate between Delphi group decision making and nominal group decision making techniques.

c. Calculate the expected value for the alternatives given below:

<table>
<thead>
<tr>
<th>Probability</th>
<th>First Cost (Rs.)</th>
<th>Salvage Value (Rs.)</th>
<th>Annual Operating Cost (Rs.)</th>
<th>Life (years)</th>
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<tr>
<td>0.2</td>
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</tr>
<tr>
<td>0.5</td>
<td>25,000</td>
<td>4,000</td>
<td>9,000</td>
<td>5</td>
</tr>
<tr>
<td>0.3</td>
<td>2,000</td>
<td>5,000</td>
<td>5,000</td>
<td>5</td>
</tr>
</tbody>
</table>

Assume an interest rate of 10% compounded semiannually.

4. a. Define span of control. Differentiate between narrow and wide spans of control and discuss their implications.

b. Define strategic planning and discuss its basic foundation. Explain how strategic planning is related to operational planning.

4'. OR

a. Define motivation and discuss the important implications of the "two factor theory" of motivation.

b. What is meant by the leadership continuum diagram? Discuss the important leadership styles on this continuum.

5. a. Differentiate between

   i. Balance sheet and income statement
   ii. Q/R inventory system and periodic inventory system

b. Discuss in detail the need and various methods used for forecasting human resource demand and supply.