MECHANICAL ENGINEERING Paper I

Time Allowed: Three Hours **Maximum Marks: 200**

INSTRUCTIONS

Please read each of the following instructions carefully before attempting questions.

Candidates should attempt **FIVE** *questions in all. Question No,* **1** *is compulsory.*
Out of the remaining **SIX** *questions attempt any* **FOUR** *questions.*
The number of marks carried by a part of a question are indicated against it.
Answers must be written in **ENGLISH** *only.*
Assume suitable data, if necessary, and indicate the same clearly.
For air R = 0.287 *kJ/kg-K,* C_p = 1.005 *kJ/kg-K,* γ = 1.4, M = 28.97 *kg/kg-mole, Universal gas constant* R = 8.314 *kJ/kg mole-K.*
Unless otherwise mentioned, symbols and notations have their usual standard meanings.
Neat sketches may be drawn, wherever required.
Attempts of questions shall be counted in chronological order. Unless struck off, attempt of a question shall be counted even if attempted partly.
Any page or portion of the page left blank in the answer book must be clearly struck off.
A psychrometric chart is attached to this question paper for necessary use by the candidate.

1. (a) 10 kg of pure ice at −10° C is separated from 6 kg of pure water at +10° C in an adiabatic chamber using a thin adiabatic membrane. Upon rupture of the membrane, ice and water mix uniformly at constant pressure. At this pressure, the melting temperature of ice is 0 °C and the latent heat of melting is 335 kJ / kg. The mean specific heat at constant pressure for ice and water are respectively 2.1 kJ/kg-K and 4.2 kJ/kg-K.

(i) Sketch the systems before and after mixing.

(ii) What is the final equilibrium temperature of the system after the completion of the mixing process?

(iii) Estimate the change of entropy of the universe due to the mixing.

(iv) Is the final phase of the system solid ice, liquid water or ice-water mixture? 10

(b) An inventor claims to have developed a device requiring no energy transfer by heat or work, yet able to produce hot and cold streams of air from a single stream of air at an intermediate temperature. Steady - state test data provided by the inventor indicate that the air enters the device at a pressure and temperature, respectively of 9 bars and 39 °C and leaves the device as cold airstream at −21 °C and as hot air-stream at 79 °C each at a pressure of 1 bar. Further, it is also noted that 40 % of the mass of air is entering the device as cold stream.

Neglecting any changes in kinetic and potential energies of the streams at inlet and exit sections and using ideal gas model with C_p and R for air, respectively at 1.005 kJ/kg-K and 0.287 kJ/kg-K, evaluate the claim using energy and entropy balances. Sketch the device as a control volume. 10

(c) (i) Using Maxwell's relations and the thermodynamic definitions for C_p and C_v in terms of gradients, show the following:

$$T.ds = C_v.dT + T\left(\frac{\partial P}{\partial T}\right)_v dv$$

$$T.ds = C_p.dT - T\left(\frac{\partial v}{\partial T}\right)_p dP$$

(ii) Joule-Thomson coefficient

$$\mu_j = \frac{1}{C_p}\left[T\left(\frac{\partial v}{\partial T}\right)_p - v\right]$$

(iii) There is no change in temperature when an ideal gas is made to undergo Joule - Thomson expansion. 10

(d) Describe the step - by - step procedure to experimentally determine the calorific

value of a solid fuel using bomb calorimeter. Draw a sectional view of the calorimeter. 10

2. (a) A four - cylinder engine of an automobile is converted to run on propane (C_3H_8) fuel. A dry analysis of engine exhaust gives volumetric percentage of CO, CO_2 and O_2, respectively at 9.79%, 4.90% and 2.45%. Write the resulting chemical reaction and find the equivalence ratio. 10

(b) The spark plug is fixed at 18° before top dead centre (TDC) in an SI engine running at 1800 r.p.m. It takes 8° of rotation to start combustion and get into flame propagation mode. Flame termination occurs at 12° after TDC. Flame front can be approximated as a sphere moving out from the spark plug which is offset 8 mm from the centre line of the cylinder whose bore diameter is 8.4 cm. Calculate the effective flame front speed during flame propagation. The engine speed is increased to 3000 r.p.m. and subsequently as a result of which the effective flame front speed increases at a rate such that it is directly proportional to 0.85 times of engine speed. Flame development after spark plug firing still takes 8° of engine rotation. Calculate how much engine rotation must be advanced such that the flame termination again occurs at 12° after TDC. 10

(c) Discuss the basic properties that a lubricant should possess to meet the lubrication requirement of internal combustion engines. 10

(d) Using a layout diagram, describe the functions of various components of a turbojet engine. 10

3. (a) Explain Reynolds analogy and derive the expression to evaluate the heat - transfer coefficient using it. Give physical meaning of the expression. 5

(b) Differentiate between fin efficiency and fin effectiveness. 5

(c) Show that the differential equation governing conduction heat transfer in a solid sphere with heat generation is given by

$$\frac{d^2T}{dr^2}+\frac{2}{r}.\frac{dT}{dr}+\frac{q'''}{k}=0$$

where T is the temperature at any radius r, q''' is the heat generated per unit volume and k is the thermal conductivity of the solid sphere. Show the general nature of the temperature distribution in this case. 5

(d) A counterflow heat exchanger is to be designed to cool 900 kg/hr of oil from 60 °C to 32 °C using a fluid with sp. heat 1.0 kJ/kg-K at 15 °C. The sp. heat of the oil is 0.5 kJ/kg - K and the maximum allowable exit temperature of the cooling fluid is 27 °C. Work out the following:

(i) Sketch the system and show the temperature distribution.

(ii) Find NTU.

If the diameter of the tube is 2 cm through which the cooling fluid passes and the overall heat – transfer coefficient is 200W/m^2-K, find the number of tubes required and the tube length. Assume density of the cooling fluid is 250 kg/m^3. If the maximum velocity through the tube cannot exceed 2 m/s and the maximum length of the exchanger is limited to 12 m due to space restriction, find the configuration of the exchanger and sketch the final design. 15

(e) Find the average film coefficient heat transfer on the water side of single - pass steam condenser. The inner diameter of the tube is 23 mm and cooling water enters at 15 °C and leaves at 25 °C. The average water velocity is 2.1 m/s. Sketch the system and show the temperature distribution.

Properties of water are given below.

Temp.	Density	Sp. heat	Thermal Conductivity × 10^2	Viscosity × 10^2	Pr.	V × 10^6
(°C)	(kg/m3)	(kJ/kg - K)	(W/m-K)	(kg/hr)		(m2/s)
10	1000	4.192	57.498	469	9.52	1.306
20	1000	4.183	59.780	361.892	7.02	1.006
30	1000	4.174	61.345	288.650	5.42	0.805

Find the heat transfer per metre length of the tube for the above case: 10

4. (a) Saturated ammonia vapour enters a 15 cm dia × 14 cm stroke twin - cylinder single - acting compressor at 0.2365 MPa whose volumetric efficiency is 79% and speed 420 r.p.m. The delivery pressure is 1.1672 MPa. Liquid NH_3 at 21 °C enters the expansion valve. For ideal cycle, find: (i) the ammonia circulated in kg/min, (ii) the refrigeration in tons and (iii) COP of the cycle.
Assume sp. heat of NH_3 as 2.19 kJ/kg-K and density 0.77 kg/m^3.
Properties of NH_3 are given below:

Pressure	Sat. temp.	Sp. Volume of	Enthalpy		Entropy	
(MPa)	(°C)	vap. at sat.	(kJ/kg)		(kJ/kg - K)	
		(m^3/kg)	Sat. liq.	Sat. vap.	Sat. liq.	Sat. vap.
0.2365	–15	0.5106	–831.46	481.52	5.4387	10.526
1 1672	+30	0.11084	–620.70	523.42	6.1853	9.9606

10

(b) A Bell-Coleman refrigeration system is used to produce 10 tons of refrigeration. The cooler and refrigerator pressure are 4.2 bars and 1.4 bars. Air is cooled in the cooler to 45 °C and temperature of air at the inlet of the compressor is –20 °C. For an ideal cycle, calculate COP, mass of air circulated/min, theoretical piston displacement of compressor and power required per ton of refrigeration. Assume C_p for air as 1.005 kJ/kg-K. Find the cylinder dimensions if the compressor is single acting single-cylinder with L/D ratio of 1.2 and runs at 600 r.p.m. 10

(c) With a neat sketch, explain the winter air-conditioning system. Why a single psychrometric process cannot be applied in winter air-conditioning? 10

(d) Calculate all the psychrometric properties of air at 1 bar and 25 °C dbt and 15 °C wbt.
The following properties of water may be assumed:

Temp.	Sat. pressure	Sp. volume of vapour	Enthalpy (kJ/kg)	
(°C)	(bar)	(m^3/kg)	Sat. liq.	Sat. vap.
25	0.03166	43.40	-	2547.3
15	0.01703	77.98	62.94	-
10	0.01078	-	-	-
0	0.01002	-	-	-

The following expression may be used, if necessary: 10

$$P_v = (P_{vsat})_{t,sat} - \frac{(P - P_{v,sat})(dbt - wbt) \times 1.8}{2854 - 1.325(1.8t_{dbt} + 32)}$$

5. (a) Considering the T-s diagram of Rayleigh flow and using the differential forms of the conservation equations and property relations, show that the
(i) Mach number is unity at the point of maximum entropy and
(ii) Mach number is 1/ $\sqrt{\gamma}$ at the Point of maximum temperature. 15

(b) Air at 1 MPa and 600 °C enters a conserving nozzle with a velocity of 150 m/s. Determine the mass flow rate through the nozzle for a nozzle throat area of 50 cm^2 when the back pressure is (i) 0.7 MPa and (ii) 0.4 MPa. Assume that the flow through the nozzle is steady, one -dimensional and isentropic.
You may use the following table for one - dimensional isentropic flow (for an ideal gas with $\gamma = 1.4$):

M	P/P_0	ρ/ρ_0	T/T_0	A/A^*	M^*
0.74	0.695	0.771	0.901	1.068	0.770
0.76	0.682	0.761	0.896	1.057	0.788
0.78	0.669	0.750	0.892	1.047	0.807
0.80	0.656	0.740	0.887	1.038	0.825
0.82	0.643	0.729	0.881	1.030	0.843

15

(c) Explain the phenomenon of boundary layer separation over a curved surface. Discuss various methods of controlling boundary layer separation. 10

6. (a) Explain what you mean by the specific speed of a turbine. Using Buckingham - π theorem and variables such as power (P), speed (N), head (H), diameter of turbine (D), density of fluid (ρ) and acceleration due to gravity (g), obtain the expression for the specific speed for a turbine. 15

(b) Explain what you mean by momentum correction factor. The velocity distribution in a pipe is given by

$$\frac{u}{U} = \left(1 - \frac{r}{R}\right)^n$$

where, U = maximum velocity at the centre of the pipe
u = local velocity along r
R = radius of the pipe Find the momentum correction factor, if n = 0.20. 15

(c) (i) Define degree of turbulence.
(ii) Explain, for boundary layer flow, whether the curve representing δ (boundary layer thickness) as a function of *x* over a flat plate is a streamline of flow or not. 5

(d) Distinguish, with the help of neat sketches, between a hydrodynamically rough surface and a hydrodynamically smooth surface. 5

7. (a) Give a neat sketch of practical feed heating arrangement of a 660 MW unit of steam turbine. Write the salient features of this system with reasonings for selecting its main parts. 10

(b) Discuss the need of governing of steam turbine. With the help of a neat sketch, discuss the working principle of hydro-mechanical speed-governing loop of a steam turbine by showing the characteristics on torque and frequency versus time and torque or load versus frequency. 10

(c) A steam power plant generating 500 MW of electrical power employs a natural circulation boiler which supplies steam at a pressure of 150 bars and temperature of 550°C. The condenser pressure is 0.05 bar. The turbine, mechanical and generator efficiencies are 87%, 98% and 99% respectively. The boiler uses pulverized coal having a calorific value of 26 MJ/kg and yields 92% efficiency. The feedwater passing through the feed heaters enters the boiler at 160°C. The risers of the furnace are 55 m high while the downcomers are placed outside the furnace for producing natural circulation. The quality of steam at the top of the riser is 12% and a minimum exit velocity of mixture leaving the risers and entering the drum is 1.4 m/s. The dimensions of the riser tubes are 65 mm OD and 3 mm wall thickness while the dimensions of downcomers are 185 mm OD and 8 mm thick. Assume no pressure drop and heat loss to the risers. Work out the following:

(i) Sketch the layout of natural circulation boiler unit showing furnace, drum, risers, downcomers, superheater, reheater and economizers and show the process on T-s diagram.
(ii) The generation of rate of steam ignoring the amount of steam bled off to feed heaters in kg/s.
(iii) The rate of fuel flow required in kg/s.
(iv) The evaporation factor
(v) The circulation ratio
(vi) The number or riser tubes
(vii) The number of downcomers
(viii) State reasons for selecting fewer in number and bigger in diameter as downcomers while more in number and smaller in diameter as riser tubes in natural circulation boiler.

Take the following properties:
h_1 = 3448.6 kJ/kg, h_{2s} = 1987 kJ/kg
h_{f3} = 117.8 kJ/kg, h_{f5} = 675.5 kJ/kg
$\rho_{riser,\ top}$ = 396 kg/m^3 $\rho_{downcomer,\ inlet}$ = 603 kg/m^3
where suffix 1, 2, 3 and 5 denote boiler exit (or turbine inlet), condenser exit,

pump inlet and boiler inlet respectively. 15

(d) With the help of a neat sketch, discuss in brief the working principle of steam pressure control system used in modern steam boilers. 5

8. (a) What do you mean by cavitation phenomena associated with hydraulic turbo machines? Discuss the causes of cavitation and its prevention with reference to hydraulic turbines. Mention the location of cavitation in hydraulic turbo pumps and turbines, and give reasons for this. 10

(b) An axial-flow compressor employed in gas turbine plant delivers air at the rate of 300 kg/s and develops a total pressure ratio of 20. The inlet stagnation conditions are 300 K and 1 bar. The isentropic efficiency of the compressor is 87%. The compressor is having 18 stages and the blade speed is kept at 200 m/s to minimize noise generation. The stage degree of reaction at the mean blade height is 50%. The axial velocity of flow is 160 m/s. The work done factor is 0.88. The hub-tip diameter ratio is 0.8. Assume actual temperature rise in each stage. Take R = 0.287 kJ/kg-K and Cp = 1.005 kJ/ kg-K. Work out the following:

(i) Sketch the system, show the process on T-s diagram and draw velocity diagrams

(ii) All the fluid angles of the first stage

(iii) The hub and tip diameters including blade height

(iv) State the reasons why the pressure rise per stage in axial-flow compressor is less than that of centrifugal compressor. 10

(c) A gas turbine power plant developing 250 MW of electrical power employs a single-shaft gas turbine reheat cycle having the following data:
Total compressor pressure ratio = 30
Total ambient conditions = 1 bar and 300 K
Polytropic efficiencies for both compressor and turbine = 0.9 each
otal turbine inlet temperature of both turbines = 1600 K each
Pressure loss in both combustors = 2% of entry pressure each
Total turbine exhaust pressure = 1.05 bars
Mechanical efficiency of assembly = 0.98
Combustion efficiency of both combustors = 0.97
Alternator efficiency = 0.97
Alternator power output = 250 MW
Actual air-fuel ratio = 25
Lower calorific value of fuel = 42 MJ/kg
Take, C_{Pa} = 1.005 kJ/kg-K and C_{Pg} = 1.16 kJ/kg-K.
Work out the following:

(i) Sketch the system and show the process on T-s diagram

(ii) The plant specific work in kJ/kg.

(iii) The mass flow rate of air required in kg/s.

(iv) The specific fuel consumption in kg/kWh.

(v) The actual thermal efficiency 15

(d) With the help of a simple sketch, discuss in brief the working principle of hydromechanical speed-governing system (prime control) of a water reaction turbine. 5

MECHANICAL ENGINEERING Paper II

Time Allowed: Three Hours **Maximum Marks: 200**

INSTRUCTIONS

Please read each of the following instructions carefully before attempting questions:

Candidate should attempt **FIVE** *questions in all. Question No.* **1** *in Section* **A** *is compulsory.*

Out of the remaining, attempt **TWO** *from Section-***B** *and* **TWO** *from Section—***C**.

All questions carry equal marks. The number of marks carried by a part of a question is indicated against it.

Answer must be written in **ENGLISH** *only.*

Unless other-wise mentioned, symbols and notations have their usual standard meanings.

Neat sketches may be drawn, wherever required.

All parts and sub-parts of a question are to be attempted together in the answer book.

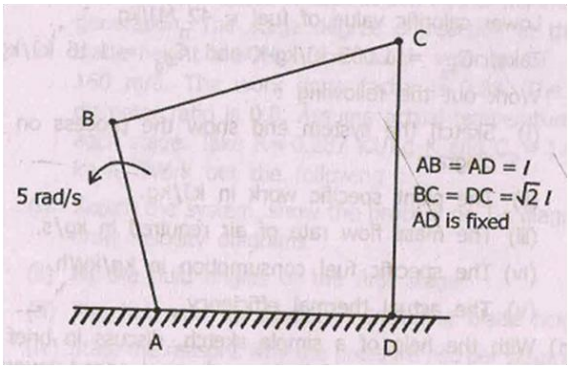
Attempts of questions shall be counted in chronological order. Unless struck off, attempt of a question shall be counted even if attempted partly.

Any page or portion of the page left blank in the answer book must be clearly struck off.

SECTION—A

1. Answer all 20 parts of the question each part carries 2 marks.

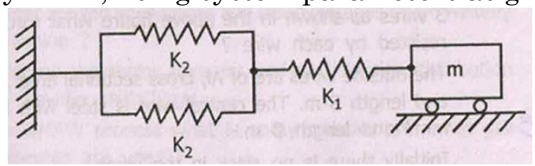
(a) The driver link AB of a four bar mechanism is rotated at 5.0 rad/s in counter clockwise direction as shown in the above figure. Locate and indicate the Instantaneous Centre (I.C.) of the coupler BC with respect to fixed link AD at an instant when BAD = 180°. Find angular velocity of the coupler using I.C. method only.



(b) A suitable reversed gear train using four gear wheels is to be used for a clock, the minute hand of which is fixed to the driving spindle and the hour hand to a driven sleeve rotating freely on the same driving spindle axis. The modular pitch is to be kept same for all the wheels and each wheel should have least number of teeth but not 11 or less. Determine number of teeth on each wheel of the gear train.

(c) A rotating disc of 1.0 m. diameter has two eccentric masses of 0.5 kg each in radii of 50 mm and 60 mm with an angular interval between them as 150° on the plane of the disc. A balancing mass of 0.1 kg is to be attached in order to balance the disc. What should be the radial distance of the balancing mass from the centre of the disc and its angular position from the eccentric mass which is at 50 mm radius?

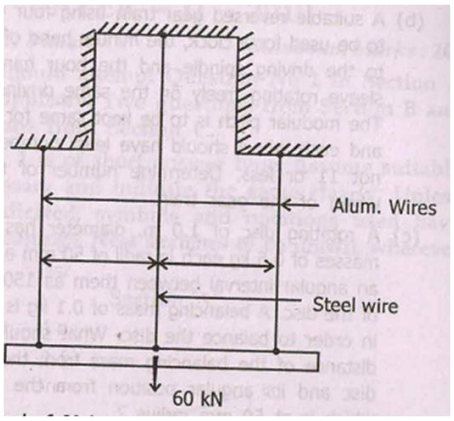
(d) Write down the differential equation of motion for the vibrating system shown in the above figure for free vibration, using D' Alembert's principle and express its natural frequency in Hz, using system parameters as given.



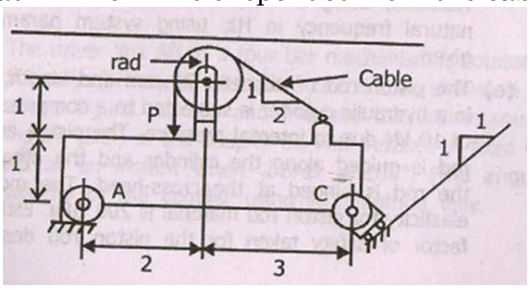
(e) The piston rod of diameter 20 mm and length 700 mm in a hydraulic cylinder is subjected to a compressive force of 10 kN due to internal pressure. The

piston end of the rod is guided along the cylinder and the other end of the rod is hinged at the cross-head. The modulus of elasticity for piston rod material is 200 GPa. Estimate the factor of safety taken for the piston rod design.

(f) If a load of 60 kN is applied to a rigid bar suspended by 3 wires as shown in the above figure what force will be resisted by each wire?
The outside wires are of Al, cross-sectional area 300 mm^2 and length 6 m. The central wire is steel with area 200 mm^2 and length 8 m. Initially there is no slack in the wires E = 2 × 10^5 N/mm^2 for Steel = 0.0667 × 10^5 N/mm^2 for Aluminium



(g) For the planar structure shown in the above figure determine the reactions or all the reaction components. All distances shown are in metres. Radius of the pulley is 0.5 m. A load P = 10 kN is suspended from the cable.



(h) Name 5 articles that are made of a thermo-plastic material. Identify the name of the specific plastic used for any 3 of the above applications.

(i) State clearly the similarities and differences among Austennite, Ferrite and Cementite.

(j) Name any 3 materials that can be classified as Ceramic. List 2 applications of each.

(k) What are effects of adding Silicon and Manganese to cast iron? Write in short about Zn-base die cast alloys.

(l) What is meant by interchangeable manufacture? Discuss a 'Go' gauge.

(m) What are the advantages and disadvantages of a-c welding machine?

(n) Discuss the terms fineness and particle size distribution in powder metallurgy.

(o) In GMAW process what is spray transfer and what gas mixtures are used?

(p) Discuss a fixture, mentioning their materials, what are duplex fixtures?

(q) Give the symbols, activity names used in method study for charting of the processes.

(r) What is float or slack and when does a subcritical path becomes critical?

(s) What is an ideal operating characteristics curve?

(t) Distinguish between material requirements planning and manufacturing resource planning.

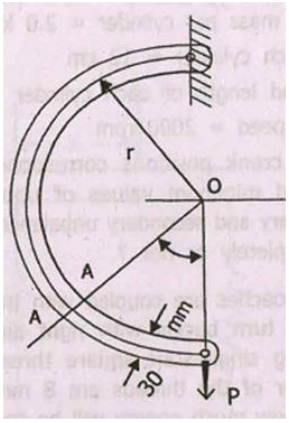
SECTION—B

2. (a) In order to evaluate mass moment of inertia of a connecting rod, the following observations were made during experimentation:
Mass of the connecting rod = 50 kg
Distance between big end bearing and small end bearing centres = 1000 mm.

Diameter of big end bearing = 100 mm.
Diameter of small end bearing = 50 mm.
Time period of oscillation while connecting rod was suspended from big end = 1.75 second.
Time period of oscillation while connecting rod was suspended from small end = 2.0 second.
Evaluate radius of gyration of the connecting rod about an axis through the centre of mass perpendicular to the plane of oscillation as well as mass moment of inertia of the rod about the same axis. 10

(b) A machine supported symmetrically on four springs has a total mass of 100 kg. It has unbalance reciprocating parts of 2.0 kg which moves through a vertical stroke of 100 mm with simple harmonic motion. The machine is having only one degree of freedom and can undergo vertical displacement. Evaluate its natural frequency and combined stiffness of the springs if the force transmitted to the foundation is one-twentieth of the applied force, when there is no damping in the system. The machine is rotating at 800 rpm. When the machine is actually tested for vibration, it is found that the damping present in the system reduces the amplitude of successive free vibrations by 30%. Evaluate:
(i) the actual force transmitted to foundation at the running speed 800 rpm.
(ii) the force transmitted in foundation at resonance, and
(iii) the amplitude of vibration of the machine due to unbalance mass, at resonance. 10

(c) A semicircular steel ring of mean radius 300 mm is suspended vertically with the top end fixed as shown in the above figure and carries a vertical load of 200 N at the lowest point. Calculate the vertical deflection of the lower end if the ring is of rectangular cross-section 20 mm thick and 30 mm wide. Value of Elastic modulus is 2×10^5 N/mm^2. Influence of circumferential and shearing forces may be neglected. 10



(d) A hollow steel rod 200 mm long is to be used as torsional spring. The ratio of inside to outside diameters is 1 : 2. The required stiffness of the spring is 100 N.m/degree. Determine the outside diameter of the rod. Value of G is 8×10^4 N/mm^2. 10

3. (a) Determine the maximum and minimum values of the primary and secondary unbalance forces due to reciprocating masses for a 90° V-twin engine, whose details are given below:
Reciprocating mass per cylinder = 2.0 kg
Stroke for each cylinder = 12 cm
Connecting rod length of each cylinder = 20 cm
Crank shaft speed = 2000 rpm
Indicate the crank positions corresponding to above maximum and minimum values of unbalance forces.
Whether primary and secondary unbalance forces can be balanced completely or not? 10

(b) Two railway coaches are coupled with the help of two tie rods of a turn buckle

with right and left handed threads having single-start square threads. Pitch and mean diameter of the threads are 8 mm and 30 mm respectively. How much energy will be spent in bringing two coaches closer through a distance of 320 mm against a steady load of 5.0 kN. Use coefficient of friction in screw thread and coupler nut as 0.12. Determine shear stress on the tie rod due to above torque. 10

(c) The data obtained from a rectangular strain gauge rosette attached to a stressed steel member are

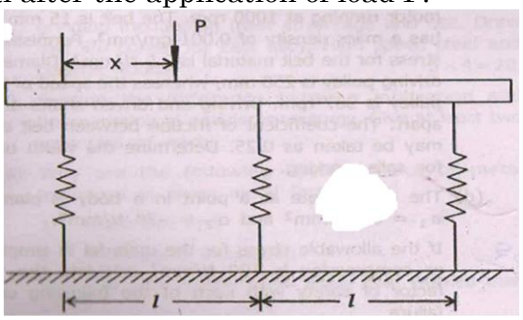
$$\varepsilon_0 = -220 \times 10^{-6},\ \varepsilon°_{45} = 120 \times 10^{-6} \text{ and } \varepsilon_{90} = 220 \times 10^{-6}.$$

Given that the value of $E = 2 \times 10^6$ N/mm^2 and Poisson's Ratio $\mu = 0.3$, calculate the values of principal stresses acting at the point and their directions. 10

(d) A spherical shell of 150 mm internal diameter has to withstand an internal pressure of 30 Mega N/m^2. Calculate the thickness of the shell if the allowable stress is 80 MN/m^2. Assume the stress distribution in the shell to follow the law

$$\sigma_r = a - \frac{2b}{r^3}, \text{ and } \sigma_\theta = a + \frac{2b}{r^3}$$ 10

4. (a) A stiff bar of negligible weight transfers a load P to a combination of three helical springs arranged in parallel as shown in the above figure. The springs are made up of the same material and out of rods of equal diameters. They are same free length before loading. The number of coils in those three springs are 10, 12 and 15 respectively, while the mean coil diameters are in ratio of 1 : 1.2 : 1.4 respectively. Find the distance 'x' as shown in figure, such that the stiff bar remains horizontal after the application of load P.



10

(b) A pair of standard spur gears has 16 and 18 teeth, module 12.5 mm and pressure angle 14.5°. Examine whether the pair will have Interference. If so, what should be the number of teeth in both the gears to avoid interference as well as the pair maintains the same speed ratio without modifying other parameters. Evaluate contact ratio for the new set. 10

(c) A flat belt drive is required to transmit 10 kW from a motor running at 1000 rpm. The belt is 15 mm thick and has a mass density of 0.001 gm/mm^3. Permissible tensile stress for the belt material is 2.5 N/mm^2. Diameter of the driving pulley is 250 mm, whereas the speed of the driven pulley is 367 rpm. Driving and driven shafts are 1.25 m apart. The coefficient of friction between belt and pulley may be taken as 0.25. Determine the width of the belt for safe working. 10

(d) The stress state at a point in a body is plane with $\sigma_1 = 60$ N/mm^2 and $\sigma_2 = -36$ N/mm^2. If the allowable stress for the material in simple tension or compression is 100 N/mm^2 calculate the values of factor of safety with each of the following criteria for failure

(i) Max Stress Criteria
(ii) Max Shear Stress Criteria
(iii) Max Strain Criteria
(iv) Max Distortion energy criteria. 10

SECTION—C

5. (a) (i) How do zirconium and thorium affect the tungsten electrone in the GTAW process? What is "weld decay" in Ni-Cr steels?

(ii) Is it possible to weld tantalum to steel, if yes, by which method? Explain the term hot cracks in welding and write four important cause.

(iii) Explain why the strength to weight ratio of die-cast parts increases with decreasing wall thickness. Explain the term stack molding.

(iv) Draw the typical configuration of Internal Centreless grinding mentioning main advantage and use. Draw tool life curves for cast alloy, High speed steel and ceramic tools. $5 \times 4 = 20$

(b) (i) Explain the difference between infiltration and impregnation in powder metallurgy. Give at least two examples of each.

(ii) Why are the following characteristics of metal important in sheet metal forming?

1. Grain size and
2. Yield point elongation

Why are pure metals more easily cold worked than alloys?

(iii) In the design of the gating system what techniques are used for minimizing turbulence? Show with a figure that the effect of alloying elements like Mn, Ni and Ti on the eutectoid temperature.

(iv) Explain with figures planetary milling. Indicate similarities between a vertical boring mill and a jig- boring machine. $5 \times 4 = 20$

6. (a) (i) Discuss short circuiting metal transfer in GMAW mini inning Its suitability. Also define the term "transition current", with figure.

(ii) Why Is a unilateral tolerance preferred over bilateral tolerance? In surface roughness, discuss with a figure Root-Mean-Square average method.

(iii) In metal casting define the terms chaplet and resin binder. Write the merits and demerits of shell moulding process.

(iv) What are a manipulator, wrist and end effector for a robot? Why has the wire EDM process become so widely accepted in industry? $5 \times 4 = 20$

(b) (i) Explain why metal powders are blended. Describe what happens during sintering. 2

(ii) What is meant by Part Programming? Discuss point- to-point control, and its applications. 3

(iii) In FMS define the terms: Automatic Guided Vehicle (AGV) and DNC. Explain the terms chucking reamers and climb milling. What effect does the helix angle have on drill performance? Explain the terms combined cuts and multiple cuts. 15

7. (a) Transportation costs from manufacturing plants to warehouses are given in table. They are in euros. Solve this problem to minimize the cost of transportation by stating the steps used in the algorithm.

Warehouse	PLANT			
	A	B	C	D
1	10	8	10	8
2	10	7	9	10
3	11	9	8	7
4	12	14	13	10

15

(b) What are moving average and exponential smoothing models for forecasting? A dealership for Honda City cars sells a particular model of the car in various months of the year. Using the moving average method, find the exponential smoothing forecast for the month of October 2010.

Take exponential smoothing constant as 0.2:

Jan.	2010	80	cars
Feb.	2010	65	cars
March	2010	90	cars
April	2010	70	cars

May	2010	80	cars
June	2010	100	cars
July	2010	85	cars
Aug.	2010	80	cars
Sept.	2010	75	cars

15

(c) Expand the following: (i) ASCII (ii) BCD (iii) MDI (iv) RAM (v) ROM 10