ZCVB-U-MCHE

MECHANICAL ENGINEERING

Paper – I

*Time Allowed : **Three** Hours*

*Maximum Marks : **200***

Question Paper Specific Instructions

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

*There are **EIGHT** questions in all, out of which **FIVE** are to be attempted.*

*Questions no. **1** and **5** are **compulsory**. Out of the remaining **SIX** questions, **THREE** are to be attempted selecting at least **ONE** question from each of the two Sections A and B.*

Attempts of questions shall be counted in sequential 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 Question-cum-Answer Booklet must be clearly struck off.

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

Unless otherwise mentioned, symbols and notations have their usual standard meanings.

Assume suitable data, if necessary and indicate the same clearly.

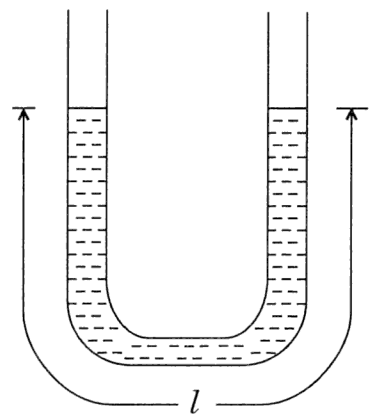
Neat sketches may be drawn, wherever required.

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

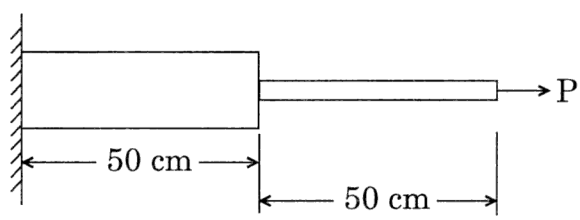
SECTION A

Q1. (a) The Porter governor has equal arms each 300 mm long and pivoted on the axis of rotation. Each ball has a mass of 5 kg and the mass of the sleeve is 20 kg. The radius of rotation of the ball is 150 mm when the governor begins to lift and 200 mm when the governor is at maximum speed. Find the range of speed of the governor. *8*

(b) A U tube open to atmosphere at both ends contains a column length l of a certain liquid. Find the natural frequency of oscillation of the liquid column. *8*



(c) A member formed by connecting a steel bar to an aluminium bar is shown in the figure below. Calculate the magnitude of the force P that will cause the total length of the bar to decrease by 0·5 mm. The Young's modulus for steel and aluminium are 2×10^5 MPa and 7×10^4 MPa respectively. The cross-sectional area of the steel bar is 25 cm^2 and of the aluminium bar is 100 cm^2. *8*



(d) Enlist the different Bravais crystal systems. Also write the relationship between their primitives and between their angles. *8*

(e) Determine the Miller indices of a set of parallel planes, which create intercepts in the ratio of 2a : 3b and parallel to the z-axis. Consider the lattice to be cubic with a = b = c = 4 Å. Calculate the interplanar spacing of the planes. *8*

Q2. (a) (i) A beam is simply supported and carries a uniformly distributed load of 50 kN/m run over the whole span. The section of the beam is rectangular having depth as 500 mm. If the maximum stress in the beam material is 150 N/mm^2 and moment of inertia of the section is 7×10^8 mm^4, find the span of the beam. *10*

(ii) Draw stress-strain curve for a ductile material and mention salient points on the curve. *5*

(b) A solid circular shaft transmits 100 kW power at 500 rpm. Calculate the shaft diameter, if the twist in the shaft is not to exceed 1° in 2 m length of the shaft, and shear stress is limited to 75 N/mm^2. Take modulus of rigidity = 1×10^5 N/mm^2. *15*

(c) Classify the point defects of a crystal structure and define each point defect with the help of suitable diagram. *10*

Q3. (a) A, B, C and D are four masses carried by a rotating shaft at radii 100, 125, 200 and 150 mm respectively. The planes in which masses revolve are spaced 600 mm apart and the masses of B, C and D are 10 kg, 5 kg, and 4 kg respectively.

Find the required mass A and the relative angular settings of the four masses so that the shaft shall be in complete balance. *15*

(b) (i) Compare Involute tooth profile with Cycloidal tooth profile of a gear. *7*

(ii) Explain different types of Cams and Followers. *8*

(c) A steel bolt is subjected to a direct pull of 20 kN and transverse shear force of 10 kN. Calculate the diameter of the bolt using maximum principal stress theory and maximum shear stress theory. Take yield point stress for steel as 250 MPa and factor of safety as 2. *10*

Q4. (a) What is Gibbs Phase Rule ? Define liquidus and solidus temperature of a phase diagram. Draw the phase diagram of a Copper-Nickel system. *15*

(b) (i) A beam of rectangular section 200 mm wide and 300 mm deep is simply supported at its ends. It carries a uniformly distributed load of 10 kN/m run over the entire span of 5 m. Taking $E = 1 \times 10^4$ N/mm^2, find the slope at the supports and maximum deflection. *10*

(ii) Derive expression for hoop stress and radial stress in case of a thin cylindrical vessel subjected to only internal pressure. *5*

(c) A rotor having a mass of 10 kg is mounted midway on a 10 mm dia shaft supported at the ends by two bearings. The bearing span is 400 mm. Because of manufacturing defects, the C.G of the disc is 0·20 mm away from the geometric centre. If the system rotates at 3000 rpm, find the amplitude of steady state vibrations and the dynamic force transmitted to each bearing. Take $E = 2 \times 10^5$ MPa. *10*

SECTION B

Q5. (a) A fixture costing ₹ 6,000 is used on shaping machine to perform an operation on a mild steel workpiece. The yearly cost of set-up is ₹ 800. The financial outlay on the money invested is, an interest at 7%, taxes and insurance at 6%, depreciation at 40% and repair at 8%. Further, a profit of 11% is desired on the money invested. Calculate the number of pieces to be manufactured in a year to earn the desired profit. The use of the fixture resulted in labour saving per piece, of ₹ 2·00 and overhead saving is 45% of labour saved. *8*

(b) A turning operation is performed on a cylindrical workpiece using the following two tools :

(i) HSS tool with nose radius of 0·6 mm.

(ii) Carbide tool without nose radius, the side cutting and end cutting angles are 25° and 5° respectively.

If the feed is 0·15 mm in both cases, calculate the maximum height of roughness obtained with HSS tool and Carbide tool. *8*

(c) Define the term Value. Explain different types of values. What do you mean by Value Analysis ? *8*

(d) The General Machine Company buys 9000 units of a particular item from ABC Company. The ordering cost is ₹ 120·00 and the carrying cost is 25% of the unit price. The discount price structure is as follows :

Order Quantity	Price per unit (P)
1 to 99	₹ 80·00
100 to 499	₹ 70·00
500+	₹ 60·00

Assuming instantaneous delivery, find (a) Economic Order Quantity (EOQ); (b) Optimum Total Cost (TC). *8*

(e) Explain the following terms with respect to 'C' programming language : *8*

(i) Functions

(ii) Arguments

(iii) Declarations

Q6. (a) An orthogonal turning operation is carried out on a mild steel cylindrical workpiece using an HSS single point cutting tool having rake angle 12° with cutting speed of 250 m/min and feed rate of 0·15 mm/rev. The depth of cut is 1·5 mm and chip thickness ratio is 0·25. If the horizontal cutting force is 700 N and vertical force is 1250 N, determine the following using the Merchant's theory : *15*

(i) Shear strain

(ii) Work done by friction

(iii) Work done by shear

(iv) Total work done

(v) Mean shear stress in shear plane

(b) Consider the following sales data :

Period	1	2	3	4
Sales	350	360	340	405

(i) Compute the exponent smoothing values for the above data using $\alpha = 0{\cdot}1$, $0{\cdot}3$ and $0{\cdot}5$; and find the respective forecasts for the fifth period.

(ii) Which 'α' has the lowest MAD (Mean Absolute Deviation) ? *15*

(c) Write 'C' program to find the product of two integers and print the result. *10*

Q7. (a) During a turning operation on a Lathe machine, if

D = Diameter of cylindrical workpiece (mm)

L = Length of workpiece (mm)

V = Cutting speed (m/min)

T_L = Tool life (min)

f = Feed rate (mm/rev)

t_m = Time to machine per piece (min)

K_1 = Direct labour and overhead cost (₹/min)

K_2 = Tool resharpening (regrinding) cost ₹/Piece

TCT = Tool changing time (min)

then prove that

(i) Optimum cutting speed for minimum cost is

$$V_{opt} = \frac{C}{\left[\left(\frac{1}{n} - 1\right)\left(TCT + \frac{K_2}{K_1}\right)\right]^n}$$

and

(ii) Corresponding optimum tool life is

$$T_{L(opt)} = \left(\frac{1}{n} - 1\right)\left(TCT + \frac{K_2}{K_1}\right)$$

where n and C are Taylor's tool life equation constants. *15*

(b) Solve the following sequencing problem and find total elapsed time. The operation time is given in minutes. *15*

	Jobs →					
Machines ↓	1	2	3	4	5	6
Machine A	8	10	11	12	16	20
Machine B	7	15	10	14	13	9

(c) The time study of a machinery operation recorded the cycle time as shown below. The workers were rated at 100%, 80% and 110%. The firm uses a 0·15 percent allowance fraction.

Cycle Time (in minutes)	Number of Times Observed
30	1
34	3
35	4
36	3
41	2

Determine the standard time by using all the three levels of Worker's rating. What is your interpretation of the results so obtained ? *10*

Q8. (a) A rectangular hole of dimensions 10 mm × 15 mm is made by electro discharge drilling in medium carbon steel plate of 6 mm thickness. The supply voltage is 220 volts and the gap is maintained in such a way that discharge takes place at 170 volts. If the resistance and the capacitance in the relaxation circuit are 45 ohm and 10 μF, respectively, determine the time required to drill that hole through the complete thickness of plate. *15*

(b) Find the initial basic feasible solution of the following transportation problem using Vogel's Approximation Method : *15*

	W_1	W_2	W_3	W_4	Factory Capacity (C)
F_1	30	25	40	20	100
F_2	29	26	35	40	250
F_3	31	33	37	30	150
Warehouse Requirement (R)	90	160	200	50	

(c) Four different jobs are to be done on four different machines. The set-up and production times are prohibitively high for changeover. Following table indicates the cost of producing job 'i' on machine 'j' in rupees. Assign jobs to different machines so that the total cost is minimized. *10*

Machines

Jobs	1	2	3	4
1	5	7	11	6
2	8	5	9	6
3	6	7	5	7
4	10	4	8	3