

MECHANICAL ENGINEERING
(Paper I)

Time Allowed : Three Hours	Maximum Marks : 300
-----------------------------------	----------------------------

QUESTION PAPER SPECIFIC INSTRUCTIONS

(Please read each of the following instructions carefully before attempting questions)

There are EIGHT questions divided in two Sections.

Candidate has to attempt FIVE questions in all.

Question Nos. 1 and 5 are compulsory and out of the remaining, any THREE are to be attempted choosing at least ONE question from each Section.

The number of marks carried by a question/part is indicated against it.

Wherever any assumptions are made for answering a question, they must be clearly indicated.

Word limit in questions, wherever specified, should be adhered to.

SECTION 'A'

1. Attempt any three of the following:

- (a) Define the following terms commonly used in laying out the cam profiles: (i) Base circle (ii) Trace point (iii) Pitch curve (iv) Pressure angle. The following notations refer to a Tangent cam with straight flank, circular nose and roller follower: R_c = Base circle radius; R_r = Roller radius; R_n = Nose radius; α = Semi-angle of action of the cam; β = Angle by which cam rotates for contact for roller with the flank; θ = Any angle by which the cam has rotated; h = Lift or the stroke at an angle θ . Draw a neat sketch of this cam. Determine the expressions for evaluating the lift (h), velocity (v) and the acceleration of the follower when the cam has turned through an angle θ (which is less than β). **20**

- (b) A hollow shaft 30 mm inner diameter and 50 mm outer diameter is subjected to a twisting moment of 800 N-m and an axial compressive force of 40 kN. Determine the factor of safety according to theories of failure based on Normal stress theory, Maximum shear stress theory and Distortion energy theory. The tensile and compressive yield strength of material is 280 N/mm^2 and Poisson's ratio = 0.3. **20**

- (c) Construct the bending moment and shearing force diagram for the beam as shown in the figure given below: **20**

[Figure: Horizontal beam ABCDEFG. Point A is the left end; hinged (pin) support at B; roller support at E; G is the free right end (overhang EFG). Distances: AB = 0.5 m, BC = 1 m, CD = 2 m, DE = 1.5 m, EF = 0.5 m, FG = 0.5 m. Loads: uniformly distributed load 20 kN/m over AB; a clockwise couple of 100 kN-m applied at C; a downward point load of 50 kN at D; a downward point load of 40 kN at F.]

- (d) What are the various types of plain carbon steel? List important mechanical properties and their common industrial applications. **20**

2. (a) A 350 N electronic instrument is attached to a ship deck which vibrates at an amplitude of 1.60 mm at 50 Hz. The instrument is to be isolated from the deck with four flexible mounts. Determine the required combined spring constant of the mounts such that the amplitude of vibration of the instrument is no more than 0.130 mm. If the springs are equal, what is the spring constant of each mount? What is the static deflection of each mount? **30**

- (b) A compressor requires 120 kW to run at 240 rpm from an electric motor of speed 750 rpm, by means of a V-belt drive. The diameter of the compressor shaft pulley should not be more than 1000 mm while the centre distance between the shafts is 2000 mm. The belt speed should not exceed 25 m/sec.

Determine the number of V - belts required to transmit the power, if each belt has a cross sectional area of 375 mm^2 , density 1000 kg/m^3 and an allowable tensile stress of 2.5 MPa. The pulley groove angle is 40° and coefficient of friction between the belt and pulley sides is 0.25. **30**

3. (a) A circular disc 50 cm outside diameter has a central hole and rotates at a uniform speed about an axis through its centre. The diameter of the hole is such that the maximum stress due to rotation is 85% of that in thin ring whose mean diameter is also 50 cm. If both are of the same material and rotate at the same speed, determine the diameter of the central hole and speed of the disc for the data given below: Allowable stress = 900 kg/cm^2 ; Specific weight = 7.8 gm/cm^3 ; Poisson's ratio = 0.3 **30**
- (b) A cantilever of length L is loaded by a uniformly increasing load, starting from zero at the free end to a maximum of w_0 at the fixed end. The free end is propped to the level of fixed end. Determine the reaction at the prop and equation to the elastic curve along with the slope at the propped end. EI is assumed constant. **30**
4. (a)(i) What are the important properties possessed by stainless steel? **15**
- (a)(ii) Give composition and uses of following stainless steels: (1) Ferritic stainless steel (2) Martensitic stainless steel (3) Austenitic stainless steel **15**
- (b) What are the composite materials? Explain major composite materials, depending upon state of reinforcing phase. **30**

SECTION 'B'

5. Answer any three of the following:
- (a) During orthogonal machining with an HSS Tool, the rake angle was 5° , the undeformed chip thickness was 0.25 mm and width of cut was 4 mm. Assuming shear strength of work material to be 350 N/mm^2 and coefficient of friction to be 0.5, estimate cutting force and thrust force. **20**
- (b) List various types of chips that are formed in cutting and the conditions in which they occur. **20**
- (c) Following is information regarding a manufacturing enterprise: Total fixed costs = Rs. 4,500; Total variable costs = Rs. 7,500; Total sales = Rs. 15,000; Units sold = 5,000. Find out: (i) Break-even point in units (ii) Margin of safety (iii) Profit (iv) Volume of sales to earn a profit of Rs 6,000 **20**
- (d) A work measurement study was conducted in a manufacturing company for 8 hours and following observations were made: Idle time: 15%; Performance rating: 120%; Allowance time: 12% of standard time; Number of units produced: 320. Calculate the standard time for the task. **20**
6. (a) In drilling of 20 mm diameter hole in a mild steel solid block of 25 mm thickness, the feed used is 0.25 mm/rev. The drill must be changed after making 10 holes if it is rotated at 250 rpm. But drill can produce 50 holes if rotated at 200 rpm. How many holes can be produced if rpm is 150? **30**
- (b) Prove that in EDM, using resistance-capacitance relaxation circuit with a constant DC source, for maximum power delivery, the discharge voltage should be 72% of supply voltage. How is the MRR affected by variation in resistance, mean current, capacitance and spark gap? **30**
7. (a) Five different machines can do any of the five required jobs, with different profits resulting from each assignment as shown in the table. Find out maximum profit possible through optimal assignments. **30**

Job \ Machine	M1	M2	M3	M4	M5
J1	30	37	40	28	40
J2	40	24	27	21	36
J3	40	32	33	30	35
J4	25	38	40	36	36
J5	29	62	41	34	39

- (b) A project is composed of eleven activities. The time estimates are given below: 30

Activity	t_0	t_p	t_m
1 – 2	7	17	9
1 – 3	10	60	20
1 – 4	5	15	10
2 – 5	50	110	65
2 – 6	30	50	40
3 – 6	50	90	55
3 – 7	1	9	5
4 – 7	40	68	48
5 – 8	5	15	10
6 – 8	20	52	27
7 – 8	30	50	40

(i) Draw the network diagram of project. (ii) Calculate slack time for each node. (iii) Determine critical path.

8. (a) What is friction hill in rolling process? State the condition of skidding in rolling. How does the roll pressure change with (i) front tension and back tension, and (ii) the roll diameter? 20
- (b) A company makes 16 gm toffees (net weight) for sale. As policy, a toffee is considered unacceptable if the net weight is more than 0.1 gm greater or less than this amount. The company took 20 samples of five toffees each (100 in total) from production line when the process was known to be in control. The average weight for 100 toffees was 16.003 gm and the average range for the 20 samples was 0.093 gm. (i) Compute the upper and lower limits for three sigma $\bar{X}$ -chart. (ii) Compute the upper and lower limits for three sigma R-chart. (iii) Based on (i) and (ii), suppose the company now samples 5 toffees from the production line. The net weight of thee toffees are 16.018, 15.870, 16.115, 16.002 and 16.005 gm. Determine whether or not the process is in control. If not, specify what the problem is and how you determined this. [Given that for sample size of 5, $d_2=2.33$; For R chart $UCL_R=d_4\bar{R}$ and $LCL_R=d_3\bar{R}$ where $d_4=2.11$ and $d_3=0$] 20
- (c) Write a “C” program to calculate the factorial of a positive integer quantity by incorporating user defined function for calculating factorial in main program. 20
