

MECHANICAL ENGINEERING (Paper I)

Time Allowed : Three Hours	Maximum Marks : 300
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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. Answer any three of the following (each answer should not exceed 200 words) **20×3=60**
 - (a) Explain the mechanism of hydrodynamic and boundary lubrications. State with justification the important properties of lubricant in each case.
 - (b) Explain with the help of velocity-and acceleration diagrams why cycloidal profile is preferred over simple harmonic motion profile for cams used in high speed applications.
 - (c) State and deduce the strain energy of distortion theory of elastic failure and compare it with maximum shear stress theory with respect to field of application and suitability for optimization.
 - (d) Write an interactive file-oriented C programme that will maintain the list of names, addresses and telephone numbers in alphabetical order (by last name). Consider the information associated with each name to be a separate record and represent each record as a structure.
2. (a) The controlling force curve of a spring-controlled governor is a straight line. The weight of each governor ball is 40 N and the extreme radii of rotation are 10 cm and 17.5 cm. If the values of the controlling force at the above radii are respectively 205 N and 400 N and the friction of the mechanism is equivalent to 2.5 N at each ball, find (i) the extreme equilibrium speeds of the governor; and (ii) the equilibrium speed and the coefficient of insensitiveness at a radius of 15 cm. **30**
 - (b) What do you understand by direct crank and reverse crank methods in balancing of engines? Explain with illustration, their significance with reference to balancing of radial engines. **30**
3. (a) A vertical shaft 20 mm in diameter and 100 cm long is mounted in long bearing and carries a rotor of mass 10 kg midway between the bearings. The centre of the rotor is 0.5 mm away from the axis of the shaft. Neglect the weight of the shaft and take $E = 200 \text{ GPa}$ for shaft material. Determine the whirling speed of the shaft and the bending stress induced in it when it is rotating at 2000 rpm. **30**
 - (b) A mild steel shaft of 200 mm diameter is to be replaced by a hollow shaft of alloy steel for which the allowable shear stress is 25% greater. If the power to be transmitted is to be increased by 20% and speed of rotation increased by 5%, determine the maximum internal diameter of the hollow shaft taking its external diameter to be limited to 200 mm. **30**
4. (a) The normal stresses at a point in a strained material across two planes at right angles to each other are 120 N/mm^2 tensile and 60 N/mm^2 compressive. The shear stress on these planes is

40 N/mm^2 . Find (i) principal stresses and principal planes; and (ii) the direct and shear stresses on a plane inclined at 30° to the vertical. **30**

- (b) A horizontal beam of square cross-section is so placed that the loading in the transverse plane is along one of its diagonals of length d . If the shear force at a section of the beam is S , draw the shear stress distribution diagram for the section and indicate the position and magnitude of the maximum shear stress on it. **30**

SECTION 'B'

5. Answer any three of the following (each answer should not exceed 200 words) **20×3=60**

- (a) Describe the use of slip gauges for measuring lengths. Outline briefly the principles of working of a mechanical and an optical comparator for comparing lengths stating their relative merits.
- (b) What are the characteristics of thermoplastic-plastics and how do they differ from thermo-setting plastics? Name the factors that influence the accuracy of moulding of plastic parts.
- (c) What is the importance of materials management in an integrated heavy industry? Explain briefly the functions of materials management.
- (d) What do you understand by value engineering? Explain the importance of human dynamics in value engineering.

6. (a) Describe with the help of a block diagram the principal components of a typical CNC system. Explain how three different functions like data input, computation and sequence control of a CNC system are integrated. **30**

- (b) What is a tool life? Write Taylor's tool life equation and explain each parameter in it. Plot a typical curve between cutting speed and tool life. A carbide tool with mild steel workpiece was found to give a life of 2 hours while cutting at 0.50 m/min . Compute the tool life if the same tool is used at a speed of 25% higher than the previous one, Also determine the value of the cutting speed if the tool is required to have a tool life of 3 hours. Assume Taylor's exponent n to be 0.27? **30**

7. (a) What is the principle behind electrical discharge machining (EDM)? Discuss briefly the process indicating voltage, current and temperature as well as its advantages and limitations. Why is proper flushing so important in this process? Suggest the required spindle movement for cutting a 5 mm cavity in steel by EDM process using (i) copper electrode and (ii) copper-tungsten electrode. Assume the wear ratio for copper electrode as 2 : 1 and for copper-tungsten electrode as 8 : 1. **30**

- (b) A motor mechanic has a specialized garage for servicing of Maruti cars, The repair time is exponentially distributed with a mean of 30 minutes. Cars arrive for repair according to Poisson distribution with a mean time of 45 minutes between arrivals. The garage has a waiting space that can accommodate two cars, excluding the one being repaired. If the waiting area is full, they can wait outside on the road. What is the expected percentage of cars that have to wait outside because of inadequate waiting space? Instead of cars waiting outside for services, any car that comes for repair goes back not to return again if the waiting area in the garage is full. Find the expected percentage of customers lost due to inadequate waiting space. **30**

8. (a) Consider the following schedule of activities and related information for construction of a new International Airport. **30**

Activity	Expected Time: Months	Expected Time: Variance	Expected Cost: Rupees $\times 10^4$ [?]
1 - 2	4	1	5
2 - 3	2	1	3
3 - 6	3	1	4
2 - 4	6	2	9

1 - 5	2	1	2
5 - 6	5	1	12
4 - 6	9	5	20
5 - 7	7	8	7
7 - 8	10	16	14
6 - 8	1	1	4

Assume that the cost and time required for one activity are not dependent upon the cost and time of any other activity and variations are expected to follow a normal distribution. Find: (i) the critical path; (ii) the expected cost of construction of the airport; (iii) the expected time required to build the airport; and (iv) the standard deviation of the expected time

- (b)** The demand for an item in a company is 18,000 units per year. The company can produce these items at the rate of 3000 units per month. The cost of one set-up is Rs. 500. The holding cost is Rs. 0.15 per unit per month. The shortage cost of one unit is Rs. 20 per year. Determine (i) Economic production quantity; (ii) Number of shortages permitted; (iii) The manufacturing time; and (iv) Time between set-ups and maximum inventory level. **30**

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