

# Mechanical Engineering

## Paper-I

**Time Allowed: Three Hours**

**Maximum Marks: 300**

- Note:* 1. The figures in the margin indicate full marks for the questions.
2. Candidate should answer questions No. 1 and 5 which are compulsory and any **three** of the remaining questions, selecting at least **one** from each section.
3. Assume suitable value for any missing data if necessary.

### SECTION – A

1. Answer any **three** of the following: 20×3=60
- (a) Derive the expression for principal stress when a plane elemental body is subjected to two mutually perpendicular direct stresses and a shear stress.
- (b) State and explain various defects in crystalline materials.
- (c) Define laser. List the various lasing materials. Explain with neat sketch the principle and working of laser beam machining.
- (d) What do you mean by Total Quality Management. Explain the concept with an example.
2. (a) Using Simplex Method solve the following Linear Programming problem :

$$\text{Maximize } Z = 10 X_1 + 15 X_2 + 20 X_3$$

$$\text{Subject to } 2 X_1 + 4 X_2 + 6 X_3 \leq 24$$

$$3 X_1 + 9 X_2 + 6 X_3 \leq 30$$

$$X_1, X_2, X_3 \geq 0$$

25

- (b) Consider the following Transportation problem involving three resources and four destinations as shown below. The cell entries represent the cost of transportation per unit.

	Destination				Supply	
		1	2	3		4
	1	3	1	7	4	300
Source	2	2	6	5	9	400
	3	8	3	3	2	500
Demand		250	350	400	200	

Obtain the initial basic feasible solution using the Vogel's Approximation Method. 25

- (c) For solving linear programming problems what are the assumptions made? Explain. 10
3. (a) Four masses A, B, C and D are completely balanced. Masses C and D make angles of  $90^\circ$  and  $195^\circ$  respectively with B in the same sense. The rotating masses have following properties:

$$\begin{aligned}
 m_B &= 25 \text{ kg}; & r_B &= 200 \text{ mm} \\
 m_C &= 40 \text{ kg}; & r_C &= 100 \text{ mm} \\
 m_D &= 35 \text{ kg}; & r_D &= 180 \text{ mm} \\
 & & r_A &= 150 \text{ mm}
 \end{aligned}$$

Planes B and C are 250 mm apart. Determine (i) the mass A and its angular position (ii) the positions of planes A and D. 35

- (b) A punching machine carries out 6 holes/min. Each hole of 40 mm diameter in 35 mm thick plate requires 8 N.m of energy /  $\text{mm}^2$  of the sheared area. The punch has a stroke of 95 mm. Find the power of the motor required if the mean speed of the flywheel is 20 m/sec.

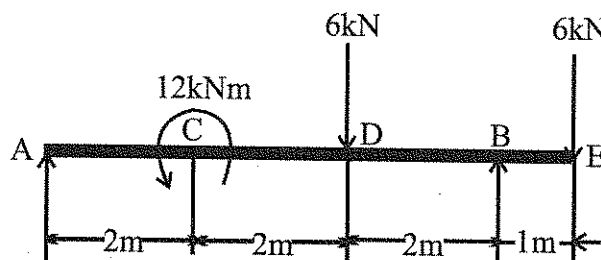
If total fluctuations of speed is not to exceed 3% of the mean speed, determine the mass of the flywheel. 25

4. (a) Explain the following heat treatment processes and the necessity of the same:
- (i) annealing
  - (ii) normalizing
  - (iii) austempering
  - (iv) cyaniding
  - (v) nitriding
  - (vi) induction hardening
- 6×6=36

- (b) Explain the importance of binary phase diagrams. Draw Cu-Ni equilibrium phase diagram and explain. 14
- (c) List various plastic, ceramics and composite materials used in industry along with their applications. 10

### SECTION – B

5. Answer any **three** of the following: 20×3=60
- (a) With neat sketches explain the construction and working of: 20
- Porter Governor
  - Hydrodynamic bearing
- (b) Derive expression for axial deflection and axial rotation for an open coiled helical spring subjected to an axial load “P” and a couple “C”. Use strain energy based approach for deriving the equations. 20
- (c) Explain with examples, the following NC part programming words/statements: 20
- Co ordinate word
  - Preparatory word/G-word
  - Feed word/F-word
  - Miscellaneous word/ M-word
- (d) (i) Write a note on flow charting, basic features of FORTRAN and C programming languages. 10
- (ii) Explain the concept of (i) work measurement (ii) Value analysis 10
6. (a) A beam has been subjected to forces and moment as shown in Figure below. Determine shear force and bending moment and draw S.F.D. and B.M.D. Mark the values of the important ordinates. 30



Figure

- (b) In a 2-D stress system compressive stresses of magnitudes 100 MPa and 150 MPa act in two mutually perpendicular directions. Shear stresses on these planes have magnitude of 80 MPa. Determine,
- (i) Principal stresses and their planes (ii) Maximum shear stress and their planes and (iii) Normal and shear stresses on a plane inclined at  $45^\circ$  to 150 MPa stress. 30
7. (a) With neat sketch explain the basic principle and working of Electro discharge machining process. Also explain the features of RC type Relaxation EDM Generator. List the applications, merits and demerits of the process. 40
- (b) Differentiate between jigs and fixtures. Explain any two types of jigs and fixtures along with neat diagrams. 20
8. (a) Construct the Network for the following project and calculate the probability of completing the project in 25 days: 30

Activity	to	tm	tp
1-2	2	6	10
1-3	4	8	12
2-3	2	4	6
2-4	2	3	4
3-4	0	0	0
3-5	3	6	9
4-6	6	10	14
5-6	1	3	5

- (b) Define Forecasting. Explain different methods of forecasting 20
- (c) Explain briefly (i) PERT and CPM (ii) ABC analysis 10