

60 – CS/11
Mechanical Engineering
Paper – I

Time : 3 hours

Full Marks : 300

The figures in the right-hand margin indicate marks.

*Candidates should attempt Q. No. 1 from Section – A and Q. No. 5 from Section – B which are compulsory and **THREE** of the remaining questions, selecting at least **ONE** from each Section.*

SECTION – A

1. Answer any **three** of the following : $20 \times 3 = 60$
 - (a) What is meant by inversion of a mechanism ? Describe with the help of suitable sketches the inversion of (i) slider crank chain and (ii) double slider chain.
 - (b) A steel cylinder of diameter 100 mm is enclosed in a copper tube of internal diameter

100 mm and thickness of 60 mm ; these two are kept rigid by keeping in between two rigid plates. An axial compressive thrust of 450 kN applied from both ends. Determine the stresses induced in copper tube and steel cylinder. Also determine the compressive strain induced. Take $E_{\text{steel}} = 20 \times 10^5 \text{ MPa}$ and $E_{\text{copper}} = 1.2 \times 10^5 \text{ MPa}$.

(c) The force acting on a bolt consists of two components an axial pull of 15 kN and a transverse shear force of 8kN. The bolt is made of low carbon steel ($S_{yt} = 310 \text{ n/mm}^2$ and the factor of safety is 2.5. Determine the diameter of the bolt using the maximum shear stress theory of failure.

(d) (i) Enumerate the general characteristics of composite materials.

(ii) Explain specific features of C-C composites.

(iii) Explain various types of defects in crystalline materials.

2. (a) The effective turning moment exerted by two stroke engine at the crank shaft is represented by the following equation :

$$T \text{ (N – m)} = 4000 + 500 \sin 2\theta - 1000 \cos 2\theta$$

where θ is the inclination of the crank to the inner dead centre. The engine speed is 360 rpm. The mass of the flywheel is 500 kg and radius of gyration is 75 cm. Determine (i) the power developed, (ii) the total percentage fluctuations in speed, and (iii) the maximum angular retardation of the flywheel. 30

- (b) Explain the following terms : 30

(i) Sensitivity

(ii) Stability

(iii) Hunting

(iv) Effort

(v) Power

(vi) Isochronism of governors

3. (a) A spring loaded safety valve of a boiler is required to blow off at a pressure of 13N/mm^2 , the diameter of the valve is 6.5 cm and the maximum lift of the valve is 1.75 cm. Select a suitable compression spring for the valve assuming the spring index 6 and providing initial compression of 3 cm. The maximum shear stress and modulus of rigidity are 4500 kg/cm^2 and $0.84 \times 10^6\text{ kg/cm}^2$. 30

(b) A column of length l with hinged ends carries a uniformly distributed load w per unit length transversely besides an axial thrust P . Determine the maximum bending moment and the maximum compressive stress. 30

4. (a) Briefly explain the procedure and precautions to be taken for carburizing, cyaniding and annealing processes. Give two applications of each. 30

- (b) Draw a schematic TTT diagram for a 0.8% plain carbon steel. Label all phase regions. 15
- (c) Explain Castigliano's theorem. 15

SECTION – B

5. Answer any three of the following :

- (a) During the machining of mild steel with $0^\circ - 10^\circ - 8^\circ - 8^\circ - 90^\circ - 2$ mm ORS shaped carbide tool, the following observations were made : 20

Depth of cut = 2.0 mm

Feed = 0.2 mm / rev

Cutting speed = 150 m / min

Chip thickness = 0.4 mm

Tangential force = 450 N

Axial force = 210 N

Calculate :

- (i) Shear force and normal force on shear plane
- (ii) Friction force and normal force on rake face

(iii) Kinetic coefficient of friction

(iv) Specific energy in cutting

(b) Explain different types of chip formation during machining, along with the mechanisms involved. 20

(c) Derive a theoretical relationship for the determination of the MRR in Electro-Chemical Machining. 20

(d) Following table gives activities and relevant important of project : 20

Activity	Optimistic	Duration in Days most likely	Pessimistic
1 – 2	30	44	54
1 – 3	8	12	16
2 – 3	1	2	3
2 – 4	2	3	5
3 – 4	8	10	12
4 – 5	14	22	25
4 – 6	3	7	11
5 – 6	6	9	18

- (i) Draw a network diagram.
- (ii) Compute project completion time.
- (iii) Identify critical path.

6. (a) Discuss the 'Merchant force diagram' and its importance in machining. 15

(b) The following information is provided about the lead time and the demand pattern of a system : 15

- (i) Annual requirement 24,500 units
- (ii) Lead time 10 days
- (iii) There are 240 working days per year
- (iv) In the past 2 years the use rate has gone as high as 140 units per day

Calculate the required safety stock and re-order level.

(c) Derive the EOQ model with the different rates of demand in different production cycles. Discuss the various approaches to determine machine capacity ? How do they differ from each other ? 15

(d) Compare CPM and PERT method for project management. What do you understand by 'Network crashing' ? 15

7. (a) What are the requirements of an electric arc welding power source ? Describe, in brief, the A. C. welding power sources with the help of suitable sketches. 15

(b) Calculate : 15

(i) Orthogonal rake

(ii) Inclination angle

(iii) Normal rake of a cutting tool having side rake (-10°), back rake (-5°) and side cutting edge angle of 30°

Sketch the above geometries for the tool.

(c) Discuss the factors influencing the choice of electrode material in EDM. Name the best electrode material for Finish machining a small die made of WC by EDM. 15

- (d) Sketch and explain the schematic diagram of AJM system. Why different abrasives produce different MRR ? And discuss the reasons for inaccuracies in AJM process.

15

8. (a) Define risers. What are its primary functions ? Design the ingate dimensions for pouring a 20 kg casting in 11 sec, with the runner having a cross-section area of 600 sq. mm and the two ingates of 25 mm width each. (Assume any missing data).

15

- (b) Why is aluminium casting preferred to be done by cold chamber than hot chamber die casting ?

15

- (c) How do you designate the coordinate axes for a CNC lathe ? Show them diagrammatically on a rough sketch of a lathe.

15

- (d) Explain the important features of a CNC machining centre.

15



Examrace