

CSM – 54/21
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 any **three** of the remaining questions, selecting at least **one** from each Section.*

SECTION – A

1. Answer any **three** questions of the following :

20×3 = 60

- What do you mean by steering gear ? Derive an expression for the fundamental equation of correct gearing.
- Explain the terms : Sensitiveness, Stability, Isochronism and Hunting in connection with Governors.

- (c) What is meant by Machinability ? What indices are used for their measurement ?
- (d) Write a short note on ECM.
2. (a) Strains at a point on a specimen are recorded with the help of a three-element rectangular rosette. The observations are as follows :
- $\epsilon_0 = 400$ strain, $\epsilon_{45^\circ} = 250\mu$ strains, $\epsilon_{90^\circ} = -300\mu$ strain

Determine the principal strains at the point.

20

- (b) A thick cylinder of inner radius 150 mm and outer radius 210 mm is subjected to internal pressure 'p' such that the maximum hoop stress developed in cylinder is 154.16 N/mm^2 . Draw the hoop stress and radial stress distribution along the thickness of cylinder. If $E = 200 \text{ GPa}$, what is circumferential strain in cylinder at the outer surface ? Given $\nu = 0.3$.

40

3. (a) What do you mean by critical speeds of a shaft ? Explain with the help of a diagram.

15

- (b) A vertical shaft is held in long bearings and a disc is attached to the shaft at its mid-point. The centre of gravity of the disc does not coincide with the axis of the shaft. Determine :

- (i) The critical speed of the shaft
- (ii) The range of speed over which it is unsafe to run the shaft

The diameter of the shaft is 15 mm and the span of the shaft between the bearing is 1m. The mass of the disc is 10 kg and the centre of gravity of the disc is 0.30 mm from the axis of the shaft. Take $E = 200 \text{ G N/m}^2$ and permissible stress in the shaft material is $70 \times 10^6 \text{ N/m}^2$.

45

4. (a) What is phase rule ? Establish the phase rule relationship between the number of degrees

of freedom, the number of components and the number of phases. 15

- (b) Draw a simplified iron-carbon equilibrium diagram and explain the salient points. 45

SECTION – B

5. Answer any **three** questions of the following :

20×3 = 60

- (a) Describe different causes of defects due to heat treatment of steels.
 - (b) What is meant by BUE ? Explain how they are formed.
 - (c) What is a flow chart ? What are the advantages and disadvantages of flow chart ?
 - (d) Write briefly the objectives of value analysis and tests for each product.
6. (a) Using Lee and Shaffer model derive a relationship for shear angle ϕ with usual notations. 20

(b) In an orthogonal cutting operation, $F_v = 1000 \text{ N}$, $F_t = 0$, rake angle 45° and shear angle 45° . Determine :

(i) The coefficient of friction

(ii) The shear power if $V_s = 20 \text{ m/min}$

(iii) The cutting power 40

7. (a) What are the objectives of work measurement and basic procedure for time study? 20

(b) A weaver wove 215.6 metres of cloth on his loom in 40 hours of actual work. Determine his production efficiency with the following data available :

Job was time standard for 16 hours continuously.

The overall performance rating = 90%

Avoidable delay during study = 180 minutes.

Fatigue allowance = 5% of total standard time

Operating conditions = standard

Unavoidable delays = 5% of total standard
time

Personal delay allowance = 5% of total
standard time

Production during time study = 65.0 metres
40

8. (a) Give a flow chart to print the average of three
numbers. 15
- (b) Write a C program to find the square root of
a number. 45

