

CSM—48/23
PART—II/PAPER—VI
MECHANICAL ENGINEERING
PAPER—I

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Time : 3 Hours

Full Marks : 250

*The question paper contains **18 (Eighteen)** questions in **GROUP—A, (12)** and **GROUP—B, (06)** together.*

GROUP—A

*Candidates to attempt **10 (ten)** questions within word limit of **250**.*

*Each question carries **15** marks.*

1. List the general characteristics of ceramic materials. What are advanced ceramics?
2. In a stressed body, at a point, on two perpendicular planes, normal stresses are +100 MPa and +60 MPa and shear stress is τ on these planes. If the maximum principal stress at the point is 136 MPa, what is the magnitude of τ ? Also, calculate the minor principal stress and the maximum shear stress.
3. A close-coiled helical spring made of round steel wire is required to carry an axial load of 800 N for a maximum stress not to exceed 150 N/mm^2 in shear. If the stiffness of the spring is 10 N/mm and the diameter of the helix is 80 mm, determine the wire diameter. Also, calculate the number of turns required in the spring. Neglect the correction due to the spring index. Given, G for steel = 84 kN/mm^2 .
4. State Grubler's criterion for ascertaining the 'degree of freedom' of a planer mechanism having turning pairs only.
5. A simply supported shaft of length 800 mm carries a mass of 60 kg placed 250 mm from one end. If $E = 200 \text{ GN/m}^2$ and the diameter of the shaft is 50 mm, find the natural frequency of transverse vibrations.

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6. The following data relates to an orthogonal turning process :

Chip thickness = 0.62 mm

Feed = 0.2 mm/rev.

Rake angle = 15°

Calculate the cutting ratio, chip reduction coefficient, shear angle and the dynamic shear strain involved in the deformed process.

7. What is Program Evaluation and Review Technique (PERT)? Write its characteristics, applications and steps in PERT.

8. Write a FORTRAN program to calculate the roots of the quadratic equation $ax^2 + bx + c = 0$ for the unknown number of sets of values for a , b and c . The program should be terminated if the value of a is negative.

9. The factorial of a positive number n is given by :

Factorial of n , $n! = 1 * 2 * 3 * 4 \dots n$

Write a C program to find the factorial of n .

10. A thick cylinder of inner radius 85 mm and outer radius 120 mm is subjected to an external pressure of 50 N/mm^2 . Determine maximum and minimum hoop stresses and show variation of hoop and radial stresses along the thickness of the cylinder.

11. A hollow circular steel shaft is required to transmit 300 HP at 200 r.p.m. The maximum torque developed is 1.5 times of the mean torque. Determine the external diameter of the shaft, if it is double the internal diameter. The maximum shear stress is not to exceed 80 MPa. Given $G = 82 \text{ kN/mm}^2$.

12. The number of teeth on each of the two equal spur gears in mesh are 40. The teeth have 20° involute profile and the module is 6 mm. If the arc of contact is 1.75 times the circular pitch, find the addendum of wheel.

GROUP—B

Candidates to attempt **05 (five)** questions within word limit of **300**.

Each question carries **20** marks.

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13. The modulus of rigidity of a material is 39 kN/mm^2 . A 10 mm diameter rod of the material is subjected to an axial tensile force of 5 kN and the change in its diameter is 0.002 mm. Calculate the Poisson's ratio and modulus of elasticity of the material.

14. What are the thermoplastics? Give some examples of engineering thermoplastics.

15. The following equation for tool life is given for a turning operation :

$$VT^{0.13} f^{0.77} d^{0.37} = C$$

A 60-minute tool life was obtained while cutting at $V = 30 \text{ m/min}$, $f = 0.3 \text{ mm/rev}$. and $d = 2.5 \text{ mm}$. Determine the change in tool life if the cutting speed, feed and depth of cut are increased by 20% individually and taken together.

16. What is inventory control? Write the advantages of inventory control.

17. Using the statement function, write a FORTRAN program to solve the differential equation $y' = -2xy^2$, $y(0) = 1$. Up to $x = 0.5$ with step length $h = 0.1$. Compare the solution obtained with the exact solution

$$y(x) = \frac{1}{1+x^2}$$

18. A single cylinder horizontal engine runs at 120 r.p.m. The stroke is 54 cm, the mass of revolving parts, assumed concentrated at the crank-pin is 100 kg and the mass of reciprocating parts is 100 kg. Determine the magnitude of the balance mass required, assuming that their centres of gravity are 21 cm from the centres of the crankshaft. Calculate the maximum value of the unbalanced horizontal and vertical forces introduced by balance. $C = 2/3$.

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SPACE FOR ROUGH WORK

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