

2019

MECHANICAL ENGINEERING
PAPER-I

Time Allowed — 3 Hours

Full Marks — 200

If the questions attempted are in excess of the prescribed number, only the questions attempted first up to the prescribed number shall be valued and the remaining ones ignored.
Answers may be written either in **English** or in **Bengali** but all answers must be in one and the same language.

Answer any five questions.

1. (a) Two similar round bars X and Y are each 300 mm long as shown in the figure 1.(a).

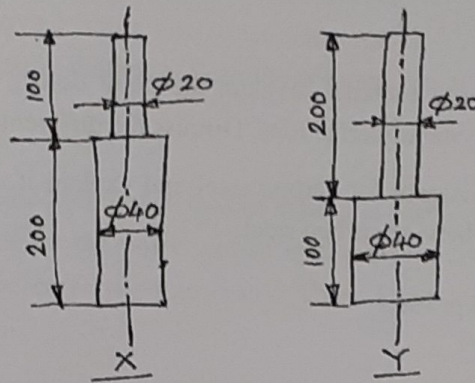


Figure 1.(a)

The bar X receives an-axial blow, which produces a maximum stress of 2500 kg/cm^2 . Find the maximum stress produced by the same blow on the bar Y. If the bar Y is also stressed to 2500 kg/cm^2 , determine the ratio of energy stored by the bars Y and X. 20

- (b) Shear force diagram for the loaded beam is shown in figure 1.(b). Determine the loading on the beam and hence draw the bending moment diagram. Locate the point of contra flexure, if any. 20

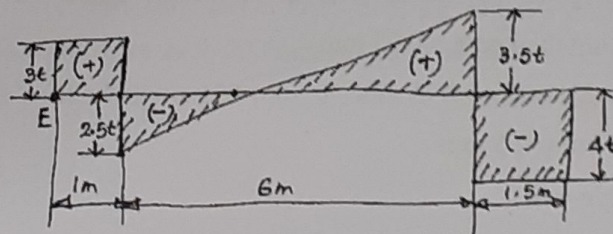


Figure 1.(b)

2. (a) A company XYZ sold 500000 litres of paints with variable cost of Rs. 28.00 per litre every year. Each litre contributes 30% of its revenue to fixed costs and profits. The company is contemplating a price reduction of 5% this year. Calculate how many more litres will the company be required to sell at the 5% price reduction in order to achieve the same profit. 20

MSC(O)ME-I/19

(2)

(b) The characteristics of project schedule are as given below:

Activity	Time (days)	Activity	Time (days)
1-2	4	5-6	4
1-3	1	5-7	8
2-4	1	6-8	1
3-4	1	7-8	2
3-5	6	8-10	5
4-9	5	9-10	7

From the above data

- (i) construct a PERT network.
 - (ii) compute the earliest and latest expected time for each event.
 - (iii) find the critical path. 20
3. (a) With the help of neat sketches, explain the point defect, line defect and surface defect in connection with crystal imperfections. Discuss the different mechanisms related to them. 20
- (b) Draw the T-T-T diagram for carbon steel and explain it. Discuss the various treatments to impart surface hardness to carbon steel. 20
4. (a) Prove that in EBM process
- $$u = 600\sqrt{E}$$
- where u = final velocity of electron, km/s
 E = potential difference by which electron is accelerated 10
- (b) Discuss about the different types of error introduced during the EDM operations. 10
- (c) Explain the working principle of ECM process. Give necessary sketch. 10
- (d) Discuss about the tool material and abrasive slurry used in USM process. 10
5. (a) During an orthogonal machining operation on ms, the results obtained are:
- Un cut chip thickness = 0.25 mm
 Cut chip thickness = 0.75 mm
 Width of cut = 2.5 mm
 Rake angle = 0°
 Cutting component of machining force = 950N
 Thrust component of machine force = 475N
- Determine
- (i) the coefficient of friction between the tool and the chip.
 - (ii) ultimate shear stress of the work material. 20

- (b) (i) Write the differences between forward extrusion and backward extrusion. 10
 (ii) Calculate the CLA value of surface roughness for the following data: 10

Sampling length = 0.8 mm

The graph is drawn to a vertical magnification of 15000 and horizontal magnification 100. The areas above and below the mean line are 160, 90, 180, 50 mm² and 95, 65, 170, 150 mm² respectively.

6. (a) A timber beam 100 mm wide × 200 mm deep is strengthened by a steel plate 100 mm wide and 10 mm thick, screwed at the bottom surface of the timber beam. Calculate the moment of resistance of the beam if the safe stresses in the timber and the steel are 100 kg/cm² and 1500 kg/cm² respectively. Take $E_s = 20E_t$. 20
 (b) Determine the ratio of the strengths of a solid steel column to that of a hollow column of the same material and having same cross-sectional area. The internal diameter of the hollow column is $\frac{1}{2}$ of its external diameter. Both the columns are of the same length and are pinned at their both ends. 20
7. (a) A three-cylinder single acting engine has its cranks at 120°. The turning moment diagram for each cycle is a triangle for the power stroke with a maximum torque of 60 N-m at 60° after the dead centre of the corresponding crank. There is no torque on the return stroke. The engine runs at 400 rpm.
 Determine
 (i) the power developed.
 (ii) the coefficient of fluctuation of speed if the mass of the flywheel is 10 kg and the radius of gyration is 88 mm.
 (iii) the coefficient of fluctuation of energy.
 (iv) the maximum angular acceleration of the flywheel. 20

- (b) Each ball of a Porter governor has a mass of 3 kg and the mass of the sleeve is 15 kg. The governor has equal arms each 200 mm long and pivoted on the axis of rotation. When the radius of rotation of the balls is 120 mm, the sleeve begins to rise and 160 mm at maximum speed.

Determine

- (i) the range of speed.
 (ii) the lift of the sleeve.
 (iii) the effort of the governor.
 (iv) the power of the governor.

What will be the effect of friction at the sleeve if it is equivalent to 8N? 20

MSC(O)ME-I/19

(4)

8. (a) The following data relate to a shaft held in long bearings:

Length of the shaft = 1.2 m

Diameter of the shaft = 14 mm

Mass of a rotor at midpoint = 16 kg

Eccentricity of centre of mass of rotor from centre of rotor = 0.4 mm

Modulus of elasticity of the shaft material = 200 GN/m²

Permissible stress of the shaft material = 70×10^6 N/m²

Determine the critical speed of the shaft and the range of speed over which it is unsafe to run the shaft. Assume the shaft to be massless. 20

- (b) Write a FORTRAN programme to solve for the roots of a quadratic equation considering the possibilities of real (equal or unequal) and imaginary roots. The input values to be supplied through key board and the output should be displayed on the monitor. 20

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