



P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Fifth Semester, B.E. - Mechanical Engineering

Semester End Examination; Dec - 2017/Jan - 2018

Design of Machine Element - I

Time: 3 hrs

Max. Marks: 100

Note: i) Answer **FIVE** full questions, selecting **ONE** full question from each unit.

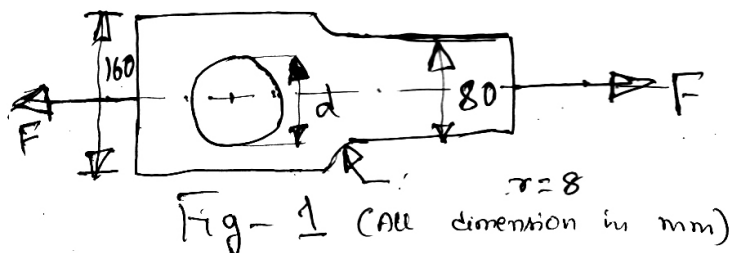
ii) Design data hand book is allowed. iii) Missing data, if any, is suitably assumed.

UNIT - I

- 1 a. List and briefly explain factors for important design considerations. 10
- b. A beam of uniform rectangular cross section is fixed at one end and carries transverse load of 1.8 kN at a distance of 0.9 m from the fixed end. The material used is C30 steel ($\sigma_y = 294.2$ MPa) and FOS is 2.5. Find the width and depth of cross section, if the depth is twice the width. 10
- 2 a. A hot rolled bar has yield stress of 390 MPa. Compute the factor of safety for the following theories of failure :
 - i) Maximum normal stress theory ii) Maximum shear stress theory
 - iii) Distortion energy theory for the following states of stress 10
 - I) $\sigma_1 = 225$ MPa, $\sigma_2 = 225$ MPa and $\sigma_3 = 0$
 - II) $\sigma_1 = 225$ MPa, $\sigma_2 = 120$ MPa and $\sigma_3 = 0$
 - III) $\sigma_1 = 225$ MPa, $\sigma_2 = 0$ and $\sigma_3 = 120$ MPa
- b. Design a Knuckle joint to connect two rods of 42 mm diameter. The ultimate strength of rods in tension is 420 MPa. Ultimate compressive and shear stresses for the material are 510 MPa and 306 MPa respectively. Take FOS as 6. 10

UNIT - II

- 3 a. What diameter of maximum hole that can be derived in a flat plate shown in Fig.1, if the stress concentration at step is same as that of the hole. 8



- b. Determine the diameter of a hollow shaft to sustain a twisting moment that fluctuates between 2.5 kN-m and 1.5 kN-m together with a bending moment that fluctuates between 2 kN-m to -2 kN-m. Assume the inner diameter to be 0.6 times the outer diameter. Take normal yield stress as 400 MPa, normal endurance stress as 270 MPa and FOS as 2. 12
- 4 a. Derive an expression for axial Impact stress. 10
- b. A beam of I section 250 mm depth has supported MI of 60×10^6 mm⁴. It is simply supported at the ends at a distance of 3 m apart. A weight of 3 kN falls at its middle from an unknown height. Take $E = 210$ GPa. Determine the safe height h taking the allowable stress as 90 MPa. 10

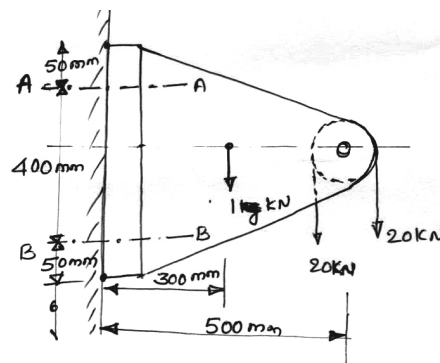
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UNIT - III

- 5 a. A hollow shaft of 400 mm outside diameter and 250 mm inside diameter is supported on two bearings 3 meter apart. The shaft rotates at 180 rpm and receives a thrust load of 300 kN and transmits 120 kW. The weight of the shaft is 90 kN. Determine the maximum normal and shear stresses induced. 20
- 6 a. Design a rigid coupling to transmit 18 kW at 1440 rpm. The allowable shear stress for CI flange is 4 MPa. The shafts, Keys and bolts are made of annealed steel having allowable shear stress of 93 MPa. Allowable crushing stress for key = 186 MPa. 20

UNIT - IV

- 7 a. The cylinder head of steam engine is subjected to a steam pressure of 0.7 N/mm^2 . It is held in position by means of 12 bolts. A soft copper gasket is used to make the joint leak proof. The effective diameter of the cylinder is 300 mm. Find the size of the bolt so that the stress in the bolt is not to exceed 100 N/mm^2 . 8
- b. A flat circular plate is used to close the flagged end of a pressure vessel of internal diameter 300 mm. the vessel carries a fluid at a pressure of 0.7 N/mm^2 . A soft copper gasket is used to make the joint leak proof. Twelve bolts are used to fasten the cover plate on to the pressure vessel. Find the size of bolts so that the stress in the bolt is not to exceed 100 N/mm^2 . 12
- 8 a. A power screw has 6 mm pitch and 40 mm diameter. The screw is subjected to an axial load of 6 kN. The length of the nut is 12 mm. Determine; 12
- i) The bearing pressure between the threads ii) The shear stress on the threads
- iii) The compressive stress in the screw.
- b. A pulley bracket is as shown in the Fig is supported by 4 bolts, two at A-A and two at B-B. Find the major and minor dia of the bolt, if allowable shear stress is 25 N/mm^2 for the material of bolt. 8



UNIT - V

- 9 a. Design a double riveted double strap butt joint for the longitudinal beam of a boiler of diameter 1.3 m with a steam pressure of 2.4 MPa. The working stresses to be used are 77 MPa in tension, 54 MPa in shear and 120 MPa in crushing. 20
- Assume joint efficiency as 81%.
- 10 a. Determine the load carrying capacity of a welded joint loaded as shown in Fig. 2. The allowable shear stress for 10 mm weld used is 50 MPa. 20

