

## MACHINE DESIGN-I

Paper-ME-309 N

Time allowed : 3 hours

[Maximum marks : 75]

Note:- Attempt five questions in all. Assume any missing data suitably.

## Unit-I

1. (i) Discuss the effect of silicon, manganese, sulphur and phosphorus on cast iron. 7
- (ii) What are the common materials used in Mechanical Engineering Design? How can the properties of steel be improved? 8

2. A cantilever is 200 mm long. It is subjected to an axial load which varies from 150 N (compression) to 450 N (tension) and also a transverse load at its free end which varies from 80 N up to 120 N down. The cantilever is of circular cross-section. It is of diameter  $2d$  for the first 50 mm and of diameter  $d$  for the remaining length. Determine its diameter taking a factor of safety of 2. Assume the following values: 15

Yield stress = 330 MPa

Endurance limit in reversed bending = 300 MPa

Correction factors = 0.7 in reversed axial loading

= 1.0 in reversed bending

( 2 )

Stress concentration factor = 1.44 for bending

= 1.64 for axial loading

Size effect factor = 0.85

Surface effect factor = 0.90

Notch sensitivity index = 0.90

3. A steam engine cylinder of size 300 mm × 400 mm operates at 1.5 N/mm<sup>2</sup> pressure. The cylinder head is connected by means of 8 bolts having yield point stress of 350 MPa and endurance limit of 240 MPa. The bolts are tightened with an initial preload of 1.8 times the steam lead. The joint is made leak-proof by using soft copper gasket which renders the effect of external load to be half. Determine the size of bolts, if factor of safety is 2 and stress concentration factor is 3. 15

4. Design a triple riveted longitudinal double strap butt joint with unequal straps for a boiler. The inside diameter of the longest course of the drum is 1.3 metres. The joint is to be designed for a steam pressure of 2.4 N/mm<sup>2</sup>.

The working stresses to be used are: 15

 $\sigma_t = 77$  MPa;  $\tau = 62$  MPa and  $\sigma_c = 120$  MPa

Assume the efficiency of the joint as 81%.

5. A hollow steel shaft is to transmit 20 kW at 300 r.p.m. The loading is such that the maximum bending moment is 1000 N-m, the maximum torsional moment is 500 N-m and axial compressive load is 15 kN. The shaft is supported on rigid bearings 1.5 m apart. The maximum permissible shear stress

( 3 )

on the shaft is 40 MPa. The inside diameter is 0.8 times the outside diameter. The load is cyclic in nature and applied with shocks. The values for the shock factors are  $K_1 = 1.5$  and  $K_2 = 1.6$ . 15

6. Design a cranked lever for the following dimensions: 15

Length of the handle = 320 mm

Length of the lever arm = 450 mm

Overhang of the journal = 120 mm

The lever is operated by a single person exerting a maximum force of 400 N at a distance of  $1/3^{\text{rd}}$  length of the handle from its free end. The permissible stresses may be taken as 50 MPa for lever material and 40 MPa for shaft material.

7. Design a shaft and flange for a Diesel engine in which protected type of flange coupling is to be adopted for power transmission.

The following data is available for design: 15

Power of engine = 75 kW;

speed of engine = 200 r.p.m.;

maximum permissible stress in shaft = 40 MPa;

maximum permissible twist in shaft =  $1^\circ$  in length of shaft

<http://www.kuonline.in> equal to 30 times  
the diameter of shaft;

maximum torque =  $1.25 \times$  mean torque;

pitch circle diameter of bolts =  $3 \times$  diameter of shaft;

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