Faculty of Engineering & Technology

Fifth Semester B.E. (Mechanical Engg./Power Engg.)

(C.B.S.) Examination

DESIGN OF MACHINE ELEMENTS

Time—Three Hours]   [Maximum Marks—80

1. (a) What are the general considerations in machine design ? Discuss the factors governing the selection of material to design machine component. 5

(b) Define at least ten mechanical properties of material giving example where these properties are required. 5

(c) Design a knuckle joint to connect two shafts made of SAE 1030 to sustain a load of 50 kN having angular movement. 10

OR

2. (a) Determine all the dimensions of a cotter joint for an external load of 90 kN which changes continuously from tension to compression. The allowable stresses in all the parts are :
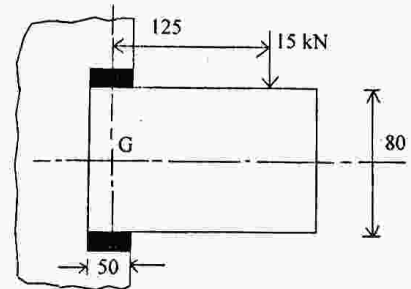
$$\sigma_t = 160 \text{ MPa}; \ \tau = 100 \text{ MPa}; \ \sigma_{cr} = 200 \text{ MPa}.$$
10

(b) Design the longitudinal joint of boiler 1.8 m in diameter for working pressure of 1.5 MPa. Assume suitable material. 10

3. (a) A bracket carrying a load of 15 kN is to be welded as shown in Fig. Q. 3(a). Find the size of weld required if the allowable shear stresses is not to exceed 80 N/mm². 10

All dimensions are in mm

Fig. Q. 3(a)

(b) The structural connection as shown in Fig. Q. 3(b) is subjected to an eccentric force of 10 kN with an eccentricity of 500 mm. The bolts are made from SAE 1120 with $S_u = 440 \text{ MPa}$ and $S_{yt} = 240 \text{ MPa}$. Assuming factor of safety of 2.5, determine the size of the bolts. 10
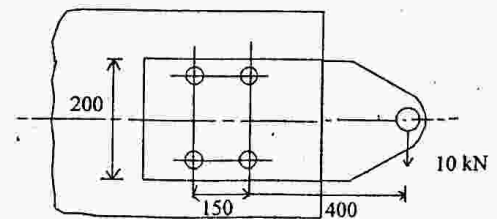
All dimensions are in mm

Fig. Q. 3(b)

OR

4. (a) A pressure vessel of 250 mm inner diameter is subjected to an internal pressure of 2.5 N/mm². Material for cylinder is SAE 1020. The top cover plate is flat circular while bottom cover plate is hemispherical and integral welded. Determine : ·

   (i) Thickness of shell.

   (ii) Thickness of bottom cover plate.

   (iii) Size and number of bolts required for top cover plate.

   (iv) Gasket for leak proof joint.

   (v) Thickness of top cover plate.   16

   (b) Give classification of pressure vessel. Which type of stresses are induced in the wall of the pressure vessel when it is subjected to an internal pressure ?

   4

5. A shaft receives 25 kW at 600 rpm from another shaft located exactly behind it through the spur gear with 400 mm diameter, mounted centrally between the two bearings. The pulley with 250 mm diameter located 200 mm to the right of right hand bearing, transmits 20 kW to another shaft in front of it by horizontal belt drive. Remaining power is transmitted by 150 mm diameter jaw clutch to another co-axial shaft. Jaw clutch is located 150 mm to the left of left hand bearing.

Determine the diameter of shaft if material of shaft is SAE 1045. Central distance between the bearings is 700 mm. Tension ratio of belt is 3 : 1. Loads are applied with minor shocks.   20

OR

6. (a) Explain what do you mean by surge in spring in detail.   3

   (b) Design a helical compression spring for a maximum load of 1000 N for a deflection of 25 mm using the value of spring index as 5. The maximum permissible shear stress for spring wire is 420 MPa and modulus of rigidity for spring material is 84 kN/mm².   7

   (c) A semi elliptic street car spring has a length of 1 m and carries a load of 40 kN. It is made up of 18 leaves, 75 mm wide, three of which are full length. Use SAE 6150 steel with a safety factor of 2.25. Suggest suitable thickness for the leaves and calculate the resulting deflection when,

   (i) the extra full length leaves are pre-stressed.

   (ii) there is no pre-stress in the extra full length leaves.   10

7. (a) Differentiate between clutch and brake. Also give different types of clutches and brakes.   5

(b) A screw made up of SAE 1020 steel with square threads is used to carry a load of 200 kN capacity jack with a maximum lift of 150 mm. Material used for the base (nut) is cast iron, I.S. grade 35. Design the screw jack. The design should include (i) Screw, (ii) Nut, (iii) Tommy bar to rotate the nut made of SAE 1020 steel. 15

OR

8. (a) A single plate clutch has to transmit 30 kW at 3500 rpm. The clutch has an impregnated asbestos lining. Assuming maximum allowable stress for shaft to be 250 MPa and other suitable data, determine the major dimensions of the single plate clutch and the axial force required to engage it. 10

(b) The block brake as shown in Fig. Q. 8(b) provides a braking torque of 360 N-m. The diameter of the brake drum is 300 mm. The coefficient of friction is 0.3. Find :

(i) The force P to be applied at the end of lever for the clockwise and anticlockwise rotation of the brake drum.

(ii) The location of the pivot or fulcrum to make the brake self locking for the clockwise rotation of brake drum. 10
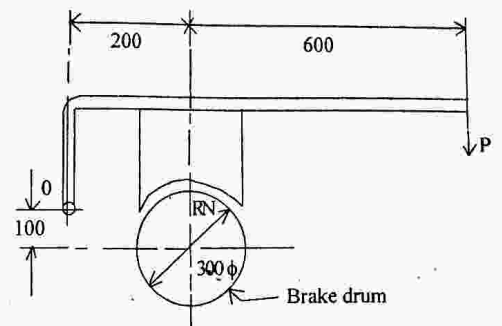
All the dimensions are in mm.

Fig. Q. 8(b)