B.E. Mechanical Engineering (Part Time) 2nd Yr 2nd Sem. Examination 2017

Machine Design I

Time: 3hrs Full marks: 100

(Answer Group A and B from the following)

Missing data if any are to be reasonably assumed.

Group A 8×5=40

Answer any five

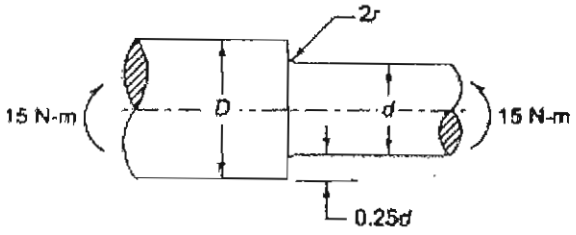
1. Why Johnson's Equation is applicable for short column and Euler's Equation for long column.
2. Draw the distribution of bending stress diagram for eccentric loaded beam and shear stress due to tensional moment of circular bar.
3. Explain with neat skeatch the different types of keys and key failure.
4. Find out the numbers of R20/3 (200,...) derived series.
5. The principal stresses induced at a point in a machine component made of steel 40C8 (σ_{yt}=380 N/mm^2) are as follows:
   σ_1=300 N/mm^2, σ_2=200 N/mm^2, σ_3=0.
   Calculate the factor of safety by (i) the maximum shear stress theory and (ii) the distortion energy theory.
6. A hollow circular shaft of outer and inner diameters of d_0 and d_i respectively is subjected to a tensional moment of M_t over a length l. The permissible angle of twist is θ degrees. Determine the outer diameter of the shaft.
7. Explain the different mechanical properties of engineering materials.
8. Explain the BIS system of designation of steels.

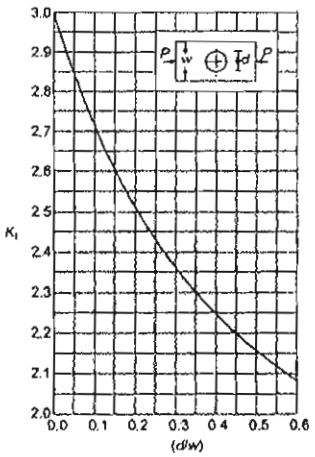
Group B 15×4=60

Answer any four

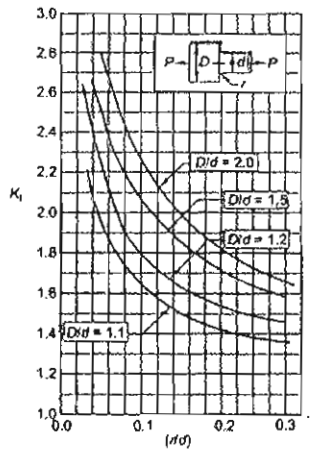
1. (a) A solid circular shaft of diameter 120 mm is subjected to an axial stress of 60 Mpa. It is further subjected to a torque of 12 kN-m. Determine the maximum principal stress experienced on the shaft.
   (b) A small element at the critical section of a component is in a bi-axial state of stress with the two principal stresses being 400 Mpa and 250 Mpa. Determine the maximum working stress according to the distorsion energy theory.
2. A shaft is required to transmit 60 kW power at 700 rpm. It is a hollow shaft, having an inside diameter 0.8 times of the outside diameter. It is made of steel (σ_{yt}=400 N/mm^2) and the factor of safety is 3. Calculate the inside and outside diameters of the shaft. Assume yield point shear stress is half of yield point tensile strength.
3. The piston rod (σ_{yt}=400 N/mm^2 and E= 2×10^5 N/mm^2) of a steam engine having length 1 m is designed on the basis of buckling strength. The factor of safety is 4. The cylinder internal diameter is 200 mm, while the operating steam pressure is limited to 1 N/mm^2. It is assumed that one end of the piston rod is fixed and other end is hinged. Determine the diameter of the piston rod.
4. A Steel flat key (σ_{yt}=380 N/mm^2, factor of safety 2.5, cross section 20×15 mm^2) is fitted into the shaft having diameter 52 mm. The power transmitted by the shaft to the hub is 25 kW at 300 rpm. Determine the length of the key.

5. A round shaft made of brittle material and subjected to bending moment of 15 N-m is shown in Figure. The stress concentration factor at the fillet is 2 and the ultimate tensile strength of the shaft material is 300 N/mm^2. Determine the diameter d, the magnitude of stress at the fillet and the factor of safety.

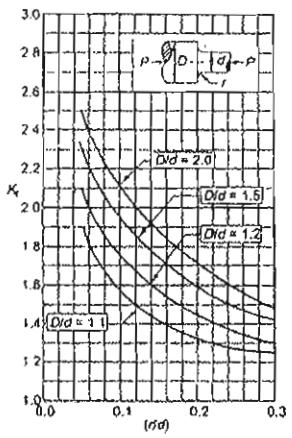




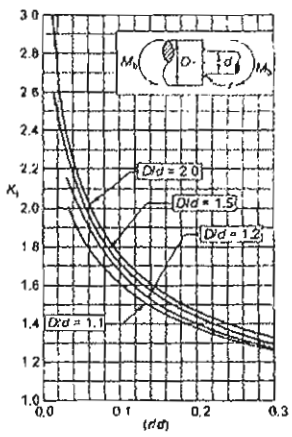
Stress Concentration Factor (Rectangular Plate with Transverse Hole in Tension or Compression)



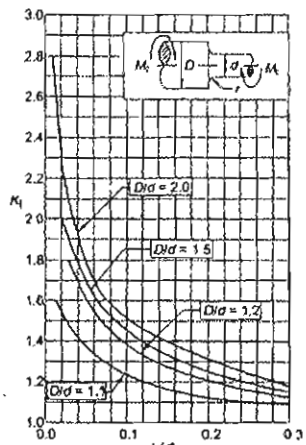
Stress Concentration Factor (Flat Plate with Shoulder Fillet in Tension or Compression)



Stress Concentration Factor (Round Shaft with Shoulder Fillet in Tension)



Stress Concentration Factor (Round Shaft with Shoulder Fillet in Bending)



Stress Concentration Factor (Round Shaft with Fillet in Torsion)