

B.E. METALLURGICAL ENGINEERING SECOND YEAR SECOND SEMESTER - 2025**MACHINE DESIGN AND DRAWING**

Time: Three hours

Full Marks: 100

Missing data, if any, are to be reasonably chosen. Give sketches wherever applicable.

Answer Question No. 1 any Five (05) questions from the rest

1. a) Discuss the significance of failure theories in the design of mechanical components. b) Estimate the yield strength in shear from yield strength in tension using Rankine's theory, Coulomb, Tresca and Guest's theory and Haigh's theory. c) A circular shaft is subjected to a bending moment of 1000 N-m and a torque of 800 N-m. Determine the equivalent stresses using the Rankine's theory, Coulomb Tresca and Guest's theory and von Mises theory. If the outer diameter of shaft is 50 mm and yield strength is 300 MPa, state whether the shaft will yield following these three failure theory of failures. Also, draw the region of safety for these three failure theories. 03+06+(12+04)
2. Design a cotter joint subjected to a tensile load of 200 kN. All components are made up of plain carbon steel. The allowable stresses are 160 MPa in tension, 240 MPa in crushing. Assume the allowable shear stress using von-Mises theory. 15
3. Draw two views of a stud. A cast iron bracket, as shown in Fig. Q3, supports a load of 50 kN. It is fixed to the wall by means of eight identical bolts, four at A and four at B. The bolts are made of steel 30C8 (Yield strength: 400 MPa) and the factor of safety is 3. Determine the nominal diameter of the bolts. 03+12
4. a) "In case of a thin cylinder subjected to internal pressure, the tendency to burst lengthwise is twice as great as at transverse section"- Justify the statement. b) Generally, for thin cylinders subjected to internal pressure, radial stresses are neglected- why? c) A rigid coupling is used to transmit 45 kW power at 1440 rpm (Consider an overload factor of 1.2). There are eight bolts and the pitch circle diameter of the bolts is 150 mm. The bolts are made of 45C8 steel having tensile yield strength of 380 N/mm². The yield strength in shear and compression can be taken as 0.5 and 1.5 times the yield strength in tension. The factor of safety can be taken as 2. Assuming that the bolts are fitted tightly into ground and reamed holes determine the diameter of the bolts. Consider the thickness of the radial flange as half of the shaft diameter. 03+02+10
5. a) Draw a typical S-N diagram for a steel specimen in a standard rotating beam test and explain the term endurance limit. Also mark the different zones on the curve clearly. b) What are the factors that affect endurance limit of a machine part? c) How the fatigue stress concentration factor is calculated? d) For a finite life problem for a given amplitude stress, how the life of the component can be determined? 05+04+03+03
6. a) What do you understand by the term- cumulative damage in fatigue? A solid circular shaft is subjected to torsional moment that varies from 100 N-m to 250 N-m and at the same time, it is subjected to bending moment that varies from -50 N-m to 150 N-m. The frequency of variation of these stresses is equal to the shaft speed. The shaft is made of plain carbon steel ($\sigma_y = 400 \text{ N/mm}^2$ & $\sigma_{ut} = 600 \text{ N/mm}^2$) and the corrected endurance limit of the shaft is 230 N/mm². Determine the shaft diameter considering a factor of safety of 1.5. 03+12
7. a) Deduce the expression of belt length for an open belt drive. b) What is the effect of belt speed on power transmission? Also, find the optimum belt speed for maximum power transmission. c) A double riveted double strap butt joint is used to connect two plates; each of 12 mm thickness, by means of 16 mm diameter rivets having a pitch of 48 mm. The rivets and plates are made of steel. The permissible stresses in tension, shear and compression are 80, 60 and 120 MPa respectively. Determine the efficiency of the joint. 04+(02+03) +06

