Registration No.: | | | | | | | | | | |

Total Number of Pages: 02 **Course: IDD (B.Tech and M.Tech)**
Sub_Code: RME6C001

6th Semester Regular/Back Examination: 2024-25
SUBJECT: Design of Machine Elements
BRANCH(S): MECH, MMEAM
Time: 3 Hours
Max Marks: 100
Q.Code: S075

Answer Question No.1 (Part-I) which is compulsory, any eight from Part-II and any two from Part-III.
The figures in the right hand margin indicate marks.

Part-I

Q1 Answer the following questions: **(2 x 10)**

a) What is factor of safety? Discuss its importance
b) What is meant by the efficiency of a riveted joint?
c) Name the modes of failure of a cotter in the cotter joint and mention the role of gib in a cotter joint.
d) Why Wahl's factor is to be considered in the design of helical compression or tension springs?
e) A leaf spring with graduated leaves is a beam of uniform strength. Explain
f) In what situation flexible coupling is used?
g) What is nipping of leaf spring?
h) What are preferred numbers?
i) Mention the assumptions made in the design of the keys.
j) What are the different types of stresses induced in bolts?

Part-II

Q2 Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve) **(6 x 8)**

a) Two steel shafts of 50 mm diameter are connected by means of a flange coupling. The flanges are welded on the shaft ends. Determine the size of the welds required on the surface of each shaft, both on the inner and outer faces of the flange, to transmit full torque capacity of the shafts. Assume the permissible shear stress in the shaft is 60 MPa, and that in the weld is 95 MPa.
b) How a shaft is different from an axle? Differentiate between strength design and rigidity design of shaft.
c) A journal bearing, 100 mm diameter and 150 mm long; carries a radial load of 7 kN at 1200 r.p.m. The diametral clearance is 0.075 mm. Find the viscosity of the coil being used at the operating temperature, if 1.2 kW power is wasted in friction.
d) State the following theories of failure and their use
  I. Maximum principal stress theory of failure
  II. Maximum shear stress theory of failure
e) Discuss in detail about the factors which govern the selection of material for the machine components.
f) A hollow shaft is subjected to a maximum torque of 1.5 kN-m and a maximum bending moment of 3 kN-m. It is subjected, at the same time, to an axial load of 10 kN. Assume that the load is applied gradually and the ratio of the inner diameter to the outer diameter is 0.5. If the outer diameter of the shaft is 80 mm, find the shear stress induced in the shaft.
g) A turbine shaft transmits 400 kW at 1000 rpm. The permissible shear stress is 80 N/mm^2 while twist is limited to 0.5^0 in a length of 2.5 m. Calculate the diameter of shaft. Take $G = 8 \times 10^4$ N/mm^2. If the shaft is chosen to be hollow with $d_i/d_o = 0.6$, calculate the % saving in the material.
h) The load on a bolt consists of an axial pull of 10 kN together with a transverse shear force of 5 kN. Find the diameter of bolt required according to the maximum principal stress theory of failure.

i) A double riveted double cover butt joint in plates 20 mm thick is made with 25 mm diameter rivets at 100 mm pitch. The permissible stresses are $\sigma_t = 120MPa; \tau = 100MPa;\ and\ \sigma_c = 150MPa$

Find the efficiency of joint, taking the strength of the rivet in double shear as twice than that of single shear.

j) A single riveted lap joint is made in 15 mm thick plates with 20 mm diameter rivets. Determine the strength of the joint, if the pitch of rivets is 60 mm. Take $\sigma_t = 120MPa; \tau = 80MPa;\ and\ \sigma_c = 160MPa$.

k) What do you mean by endurance strength of a material? How do the size and surface condition of a component and type of load affect such strength?

l) Write short notes (any two)

I. Stages in design
II. Endurance limit and factors affecting it
III. Notch sensitivity

Part-III

Only Long Answer Type Questions (Answer Any Two out of Four) **(16 x 2)**

Q3 a) A safety valve of 60 mm diameter is to blow off at a pressure of 1.2 N/mm². It is held on its seat by a close coiled helical spring. The maximum lift of the valve is 10 mm. Design a suitable compression spring of spring index 5 and providing an initial compression of 35 mm. The maximum shear stress in the material of the wire is limited to 500 MPa. The modulus of rigidity for the spring material is 80 kN/mm². Calculate: i. Diameter of the spring wire, ii. Mean coil diameter, iii. Number of active turns, and iv. Pitch of the coil. **(8)**

Take Wahl's factor,

$$K = \frac{4C-1}{4C-4} + \frac{0.615}{C} = 1.31$$

Where C is the spring index.

b) A locomotive semi-elliptical laminated spring has an overall length of 1m and sustains a load of 70kN at its centre. The spring has 3 full length leaves and 15 graduated leaves with a central band of 100 mm width. All the leaves are to be stressed to 400 MPa, when fully loaded. The ratio of the total spring depth to that of width is 2. E = 210 kN/mm². Determine **(8)**

(i) The thickness and width of the leaves
(ii) The initial gap that should be provided between the full length and graduated leaves before the band load is applied.

The load exerted on the band after the spring is assembled.

Q4 a) Design a journal bearing required to resist a radical load of 8 kN. The oil used has a viscosity of 0.0087 kg/m-s at the operating temperature of 80^{0}C. Shaft speed is 720 RPM. Bearing diametral clearance may be assumed as 0.00025 mm per mm diameter, and ambient temperature is 30^{0}C. If heat radiating capacity of the bearing is 150 N-m per second per square meter of projected area of bearing per ^{0}C; determine whether artificial cooling is necessary? **(8)**

b) A foot-step bearing supporting a vertical shaft is required to resist a load of 7 kN, while the shaft running at 120 RPM. Allowable bearing pressure is 2 N/mm². If the coefficient of friction is 0.05, calculate the power lost in friction at the bearing. **(8)**

Q5 A rectangular steel plate 100 mm wide is welded to a vertical plate to form a cantilever with an overlap of 50 mm and an overhang of 150 mm. It carries a vertical downward load of 60 kN at free end. Fillet weld is done three sides of the plate for a permissible stress of 140 N/mm². Determine the size of the weld. **(16)**

Q6 A knuckle joint is to transmit a force of 140kN, Allowable stresses in tension, shear and compression are 75 N/mm², 65 N/mm² and 140 N/mm² respectively. Design the joint. **(16)**