(3 hours) **[Total Marks: 80]**

N.B.: 1. **Question no. 1 is compulsory.**
2. Attempt **any three** questions from the remaining.
3. Figures to the right indicate full marks.
4. Make and state the assumptions clearly wherever required.
5. Answers to the same questions should be grouped together.
6. Provide neat sketches to illustrate your answers.
7. Use of Design Data books such as PSG and Mahadevan are permitted.

Q1. Attempt **any four:** **[20]**

a) Briefly discuss about the various stresses induced under load in a helical compression spring of circular wire cross section.

b) Explain different types of keys used for fastening and their application areas.

c) Elaborate on factor of safety and its significance in designing.

d) Explain different types of welded joints and their strength computations.

e) How would you check the bending stress induced in the pin of a knuckle joint? What is the significance of this check?

Q2. **a)** Design a cotter joint to resist an axial load of 60 kN. All parts of the joint are made up of same material having permissible stresses as under: **[12]**
$f_t = 70\,MPa;\ f_s = 50\,MPa;\ f_c = 100\,MPa$

b) A cast iron cylinder of internal diameter of 340 mm and outer diameter of 420 mm is subjected to an internal pressure of 6 N/mm^2. Determine and plot the distribution of tangential and radial stresses along the cylinder wall cross section, choosing the inner, middle and outer points. **[08]**

Q3. **a)** Design a shaft to transmit power from an electric motor to a machine through a pulley by means of horizontal flat belt drive. The pulley having a diameter of 200 mm and weighing 200 N is mounted with an overhang of 100 mm from centre of the bearing. The max. power transmitted is 1.2 kW at 120 r.p.m. The angle of contact of the belt is 180° and the coefficient of friction between the belt and the pulley is 0.3. Assume combine shock and fatigue factors in bending moment and torque as 2 and 1.5 respectively. Allowable shear stress in shaft material is 40 N//mm^2. **[12]**

b) The critical cross section of a crane hook in its simplified form is trapezoidal in shape with 90 mm and 30 mm as the lengths of its parallel sides and 120 mm as its height. The bed diameter of crane hook is 100 mm. The yield stress in tension for the material of the crane hook is 380 N/mm^2 and Factor of safety is 3.
Determine the load bearing capacity of the crane hook. **[08]**

Q4. **a)** Design a close coiled helical compression spring for a service load ranging from 2250 N to 2750 N. The axial deflection of the spring for this load range is 6 mm. Assume a spring index of 5. The permissible shear stress intensity and modulus of rigidity for the material of the spring are 420 MPa and 84 kN/mm^2 respectively. Assume squared and ground ends as the end connection for the spring.
Prepare a neat sketch of your design. **[08]**

b) Design a rigid flange coupling to transmit 15 kW at 720 rpm between two shafts. Assume appropriate materials and stresses for the different components of the coupling with due justification thereof.
Prepare a neat sketch of the coupling that you have designed. **[12]**

Q5. **a)** Design a spur gear drive for transmitting 25 kW at 400 rpm of the pinion. Use the following particulars **[12]**

i) Velocity ratio = 1.2
ii) Allowable static stress for pinion material = 150 N/mm^2.
iii) Allowable static stress for gear material = 120 N/mm^2.
iv) No. of teeth on pinion = 20.
v) Face width = 14 times module.
vi) Tooth profile = 20° full depth, involute.

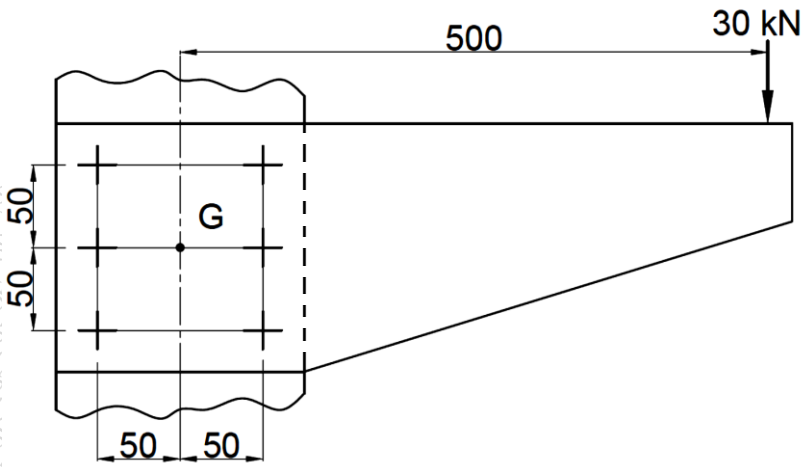
Tooth form factor, $Y = 0.154 - \frac{0.912}{\text{No. of teeth}}$.

Velocity factor, $K = \frac{3}{3 + v}$ where v is the pitch line velocity in m/sec.

b) Prepare a neat sketch showing details of a triple riveted, double strap butt joint incorporating unequal straps for riveting the longitudinal seams of a pressure vessel. Explain with relevant sketches and equations the procedure for designing this joint conforming to Indian Boiler Regulations. **[08]**

Q6. **a)** Explain 'Bolts of uniform strength' and their applications. Explain the procedure of designing bolted joints for fluid tight applications. **[08]**

b) A horizontal bracket is riveted to a vertical column using 6 rivets as shown in figure. A load of 30 kN is acting on the horizontal bracket, as shown. Determine the size of the rivets to be used. Assume the shear stress in the material of the rivet as 50 N/mm^2. **[12]**



(All dimensions are in mm)