VASAVI COLLEGE OF ENGINEERING *(Autonomous)*, HYDERABAD
B.E. (Mech. Engg.) III Year II-Semester Main Examinations, May-2017

Machine Design

Time: 3 hours   Max. Marks: 70

Note: Answer ALL questions in Part-A and any FIVE from Part-B

Part-A (10 × 2 = 20 Marks)

1. Wire diameter of a helical compression spring is 3mm and its mean diameter is 18mm. what are the values of spring index and Wahl's correction factor, k? If the allowable shear stress is 70 MPa, what is the maximum axial load that can be applied neglecting the direct shear load?

2. A semi elliptical multi leaf spring has two extra full length leaves and ten graduated leaves. Material of spring leaves is steel of allowable bending stress of 600 MPa and modulus of elasticity 2.07×10^5 MPa. Span of the spring is 1.2 m and central load is 30 KN. What is the deflection of the spring if width and thickness of each leaf are 60mm and 12mm respectively? What is the bending stress in the leaves?

3. What are the two basic modes of gear teeth failures? How can complete breakage of tooth be avoided?

4. Two gear wheels with 18 and 72 teeth are in mesh and face width is 50mm. Module is 5mm and wear strength of gear material is 10850N. Determine its BHN?

5. Define the terms thick film and thin film lubrications.

6. In a hydrodynamic bearing radial load is 3.2 KN, speed of journal is 1440 rpm, journal diameter is 50mm, length of the bearing 60mm, diametral clearance is 0.1mm and viscosity of lubricant is 25 centi poise. What is the value of Somerfield number?

7. List the materials for I.C. Engine piston.

8. Area of cross section of a 300mm long connecting rod is 539mm² and its density is 8000kg/m³. Speed of engine is 150 rpm and crank radius is 62.5 mm. determine the bending moment on connecting road due to whipping action.

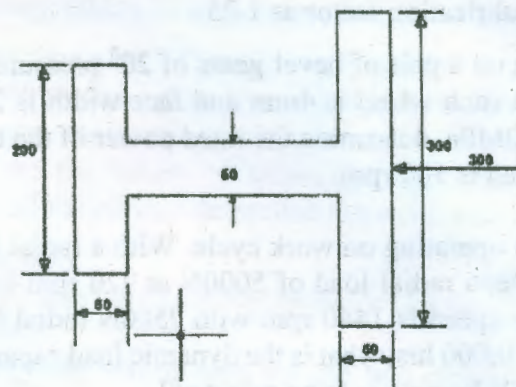9. Locate the neutral axis of an I-section curved beam whose cross section is given in figure 9.

Figure 9

10. For a crane hook with trapezoidal cross section, position of neutral axis from center of curvature is 89.18 mm and centroidal axis is 100mm from the center of curvature. Inside surface radius of curvature is 50mm. Area of cross section of beam is 7200mm². If maximum allowable stress in the cross section is 120MPa, what is the maximum load that can be applied on the curved beam through a line passing through its center of curvature?

Part-B (5 × 10 = 50 Marks)
(All bits carry equal marks)

11. a) A helical compression spring is used in a balance to measure 0 to 1200N load over a scale of length 100mm. The spring is to be enclosed in a space of 35mm diameter. Number of active turns in the spring is 23 and total number of turns is 25. Taking modulus of rigidity of spring material as $0.84*10^5$ MPa, determine wire diameters and mean coil diameter of the spring. What is the maximum shear stress in the spring taking Wahl's correction factor into consideration? If allowable shear stress is 1000MPa, is the design safe?

   b) Figure 11b shows a 700mm long cantilever beam of uniform strength in the form of triangular plate of 500mm width at fixed end and 12mm thick. The cantilever beam is propped by a helical compression spring placed below it at the free end. What is the force when applied at the free end causes a deflection of 35mm, if there are 10 active coils in the spring of 80mm mean diameter and 10mm wire diameter? Take modulus of rigidity for coil spring as 0.84×10^5 MPa and modulus of elasticity for leaf spring as 2.1×10^5 MPa.
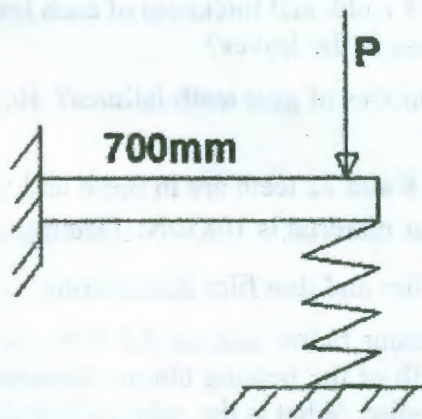

Figure 11.b

12. a) A pair of helical gears transmits 12KW at 10,000 rpm of the pinion. Number of teeth on pinion and gear are respectively 20 and 80. The teeth are 20^0 stub in diametral plane and helix angle is 45^0. Static strength of both the wheels is 100MPa. What is the face width of each gear wheel, from strength point of view alone? Take module of both the wheels as 2mm and wear lubrication factor as 1.25.

   b) Number of teeth on a pair of bevel gears of 20^0 pressure angle is 20 on pinion and 40 on gear. Module on each wheel is 4mm and face width is 20mm. If static strength for both the wheels is 200MPa, determine the rated power of the drive from strength point of view, when pinion speed is 500 rpm.

13. a) A ball bearing is operating on work cycle. With a radial load of 3000N at 1440 rpm in the first quarter cycle, a radial load of 5000N at 720 rpm for next half cycle and during last quarter cycle the speed is 1440 rpm with 2500N radial load. If total life of the bearing is estimated to be 10,000 hrs, what is the dynamic load capacity of the bearing based on which a deep groove ball bearing is to be selected?

   b) A journal of 50mm diameter rotates at 1440 rpm in a journal bearing of 50mm long. If viscosity of lubricant is 18 centiPoise, determine the maximum radial load the journal can carry under hydrodynamic lubrication conditions. Diametral clearance is 0.119mm and take Somerfield number as 0.0446. What is the change in oil required, if Somerfield number is to be 0.0316 keeping other parameters same?

14. a) Determine crown thickness of C.I trunk piston for a single cylinder 4 stroke engine of 5KW power at 600 rpm speed. Diameter of bore is 120mm, maximum explosion pressure is 4.5MPa, heat supplied to engine is 19000KJ/KWh and 6% of heat is conducted through the crown. Heat conduction factor is 46W/M/^{0}C and the temperature difference from center to edge of crown is 250^{0}C. Take allowable tensile stress for piston material as 35MPa and for piston rings radial wall pressure must be below 0.03MPa and permissible tensile stress is 80MPa. Also determine the diameter of piston rings (5+1) and skirt length. Assume that side thrust is 9% of gas load and permissible bearing pressure is 0.4MPa.

b) Determine the diameter of circular cross section connecting rod of a diesel engine, if cylinder bore is 120mm, stroke length is 140mm, length of connecting rod is 420mm and maximum combustion pressure is 4.5MPa. Assume yield stress in compression as 330 MPa. Neglect whipping effect and take engine speed as 1500 rpm.

15. a) An S-link is made of 25 mm diameter steel rod and subjected to a load of 1KN as shown in figure 15a. Locate the neutral axis for the cross section. What is the maximum bending moment? Find the magnitude of direct normal stress. Determine the maximum tensile stress in the link.

b) A C-frame of rectangular cross section is subjected to an eccentric load of 15KN as shown in figure 15b. If the frame is made of Cast Iron FG300, determine the cross section if width is five times the thickness and factor of safety is 2.5.
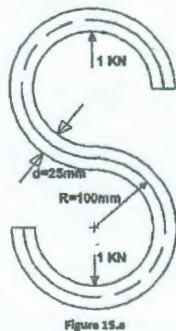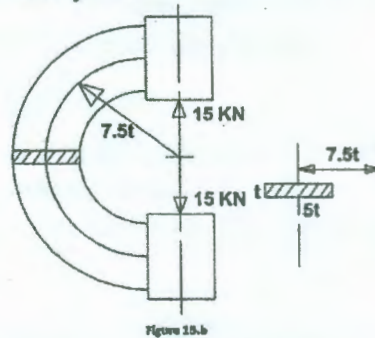

Figure 15.a   Figure 15.b

16. a) A helical compression spring is initially compressed with a preload of 375N and when it is fully compressed to 750N, the torsional shear stress in spring cross section is found to be 750N/m^2. Outer diameter of the spring is 42 mm. Determine the wire diameter and mean coil diameter for the spring, taking Wahl's correction factor into consideration.

b) A pair of parallel helical gears of 25^0 helix angle and 20^0 involute profile are in mesh. Pinion has 20 teeth and 40 teeth on gear. Normal module is 3mm. Calculate the transverse module, transverse pressure angle, axial pitch, pitch circle diameters of pinion and gear and center distance. What are the values of addendum and dedendum? If 2KW power is transmitted at 1440 rpm of the pinion, determine the axial load on gear.

17. Answer any *two* of the following:
    a) Derive an expression for static load carrying capacity of a ball bearing.
    b) Write notes on crank shafts.
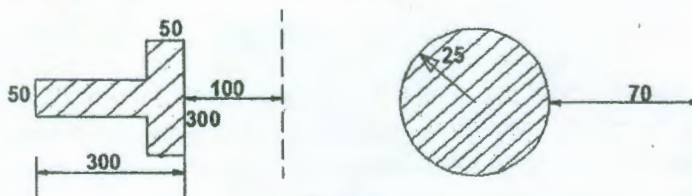   c) Determine the position of the neutral axis for the two cross sections of a curved beam shown in figure 17c.

Figure 17.c