B.E / B.Tech (Full Time) DEGREE END SEMESTER EXAMINATIONS, Nov/Dec 2011

AGRICULTURAL AND IRRIGATION ENGINEERING BRANCH

FIFTH SEMESTER

AI 9305 – DESIGN AND DRAWING OF AGRICULTURAL MACHINERY

Use of approved design data book permitted.

Time : 3 hr. Max. Mark :100

Answer ALL Questions

Part A (10 x 2 = 20 Marks)

1 State the assumptions used in deriving the bending equation, $M/I = \sigma/y = E/R$.

2 What is meant by *design based on strength* and *design based on rigidity*?

3 Define endurance limit. List the significant factors that influence it.

4 Write the basic relations for design of i) shafts in parallel ii) shafts in series.

5 Mention the types of stresses that occur in a flat belt and V-belt.

6 How does pressure angle of gears influence the design of gear shaft in terms of i) bending load and ii) power transmitted?

7 Bending stress distribution at any section of a straight beam is linear. What is the distribution in a curved beam?

8 Why is velocity ratio not constant in a roller chain drive? How can the uneven velocity ratio be reduced?

9 What are antifriction bearings? Mention one of its types used in combined load (both radial and thrust) application.

10 List the types of gear tooth failures and the type of stresses associated with it?

PART B (5 x 16 = 80 Marks)

11 A shaft made of 40C8 steel is used to drive a machine. The locations of bearings A, D and the pulleys B, C and their sizes, belt tensions when the shaft rotates at 1500 rpm are shown in *Fig.1*. Length AB = BC = CD = 250 mm;

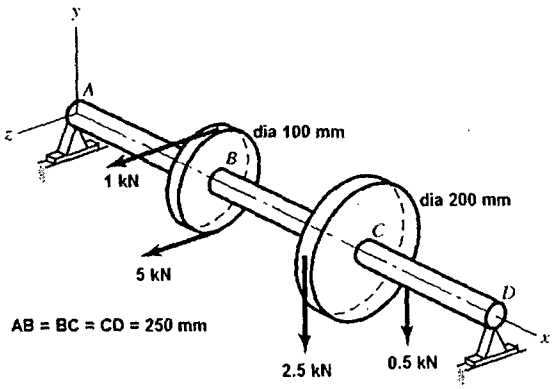


Figure 1

The permissible shear stress for the shaft material is 100 MPa. The combined shock and fatigue factor applied to bending and torsion are 1.5 and 1.2 respectively. Determine the diameter of the shaft and the location of greatest stresses. Assume simply supported condition at the bearings. (16)

12a Design a bushed-pin type flexible coupling for connecting a motor shaft to pump shaft for the following service conditions:
Power to be transmitted = 50 kW; Speed of motor shaft = 1500 rpm;
Diameter of motor shaft = 60 mm and Diameter of pump shaft = 45 mm.
The bearing pressure in the rubber bush and allowable stress in the pins are to be limited to 0.5 MPa and 20 MPa respectively.
Draw a free hand sketch of the coupling and their dimensions. (16)

[OR]

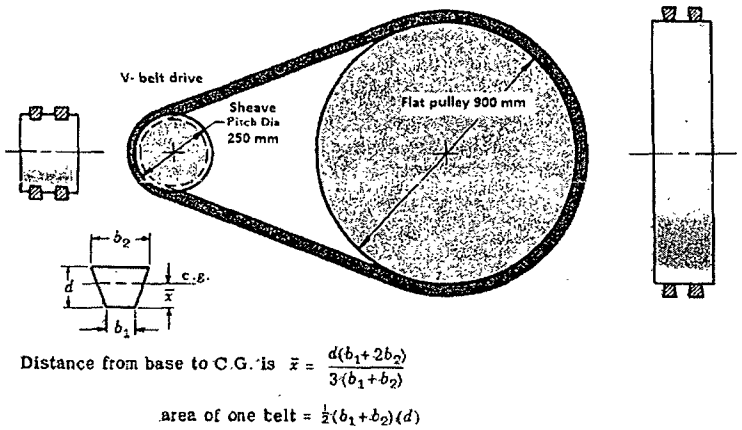
12b Two shafts made of plain carbon steel are connected by a rigid protective type flange coupling. The shafts are running at 1000 rpm and transmit 25kW power. Design the coupling completely for over-load capacity 50% in excess of mean transmitted torque capacity. Assume the following permissible stresses for the coupling components:
Shaft – Permissible tensile stress = 75 MPa; Permissible shear stress = 40 MPa;
Keys – Rectangular sunk key with Permissible compressive strength = 75 MPa;
Bolts – Six numbers made of steel having permissible shear stress = 30 MPa;
Flanges – Cast iron having permissible shear stress = 15 MPa;
Draw a free hand sketch of the coupling and their dimensions.

(16)

13a Design an open flat belt drive to transmit 110 kW at a belt speed of 25 m/s between two pulleys of diameters 250 mm and 400 mm having a centre distance of 1 m. The allowable belt stress is 8.5 MPa and the belts are available having a thickness to width ratio of 0.1 and a material density of 1100 kg/m^3. Given that the coefficient of friction between the pulleys is 0.3, determine the minimum required belt width. What would be the necessary installation force between the pulley bearings and what will be the force between the pulley bearings when the full power is transmitted? Suggest the type of bearing (radial or thrust) to be used for the above design. (16)

[OR]

13b A V-belt drive, shown in *Fig.2* is to transmit 20 kW from a 250 mm pitch diameter sheave (drum with V grooves) operating at 1800 rpm to a 900 mm diameter flat pulley. The center distance between the input and output shafts is 1 m. The groove angle $\theta = 40^\circ$, and the coefficient of friction for the belt and sheave is 0.2, and the coefficient of friction between the belt and flat pulley is 0.2. The cross section of the belt is b_2 = 36 mm wide at the top and b_1 = 20 mm wide at the bottom by d = 25 mm deep. Density of the belt is 27 g/cm^3 and the allowable tension per belt is 900 N. How many belts are required? (Hint: analyze for one belt first) (16)



Distance from base to C.G. is $\bar{x} = \frac{d(b_1+2b_2)}{3(b_1+b_2)}$

area of one belt = $\frac{1}{2}(b_1+b_2)(d)$

Figure 2

14a Design and draw a spur gear drive transmitting 30 kW at 400 r.p.m. to another shaft running approximately at 100 r.p.m. The load is steady and continuous. The materials for the pinion and gear are cast steel and cast iron respectively. Take module as 10 mm. Also check the design for dynamic load and wear.
Assume: σ_P = 140 MPa ; σ_G = 56 MPa ; T_P = 24 ; C_v = 3/(3+v) where v is in m/s; y = 0.154 – (0.912 / No. of teeth); σ_e = 84 MPa ; e = 0.023 mm ; σ_{es} = 630 MPa ; E_P = 210 GPa ; E_G = 100 GPa; (16)

[OR]

14b A 90° bevel gearing arrangement is to be employed to transmit 4 kW at 600 r.p.m. from the driving shaft to another shaft at 200 r.p.m. The pinion has 30 teeth. The pinion is made of cast steel having a static stress of 80 MPa and the gear is made of cast iron with a static stress of 55 MPa. The tooth profiles of the gears are of 14.5° composite form.
The tooth form factor may be taken as y' = 0.124 – (0.684 / T_E), where T_E is the formative or equivalent no. of teeth and velocity factor, C_v = 3 / (3 + v), where v is the pitch line speed in m/s, and face width is 1/3 of the slant height of pitch cone. Determine the module, face width and pitch diameters for the pinion and gears, from the standpoint of strength and check the design from the standpoint of wear. Take surface endurance limit as 630 MPa and modulus of elasticity for the material of gears is E_P = 200 GPa and E_G = GPa. (16)

15a
i) List the assumptions used in the theory of hydrodynamic lubrication. (3)
ii) Explain the theory of thick film lubricated bearings with figure. (10)
iii) Sketch the pressure distribution in axial radial directions of a journal bearing with thick film lubrication. (3)

[OR]

15b
i) Calculate the tolerances, fundamental deviations and limits of size for hole and shaft in 60 H7 / m6 fit. Determine the maximum values of clearance and interference. (8)

ii) Explain the mechanism of rolling friction and list the factors on which the coefficient of rolling friction is dependent. (8)