ii. The layout of a transmission shaft carrying two pulleys B and C and supported on bearings A and D is shown in figure 3. Power is supplied to the shaft by means of a vertical belt on the pulley B, which is then transmitted to the pulley C carrying a horizontal belt. The maximum tension in the belt on the pulley B is 2.5 kN. The angle of wrap for both the pulleys is 180° and the coefficient of friction is 0.24. The shaft is made of plain carbon steel 30C8 (S_{yt} = 400 N/mm^2) and the factor of safety is 3. If the larger pulley has the diameter of 300mm and smaller one has 150mm diameter. Determine the shaft diameter on strength basis. **7** 03 01 03

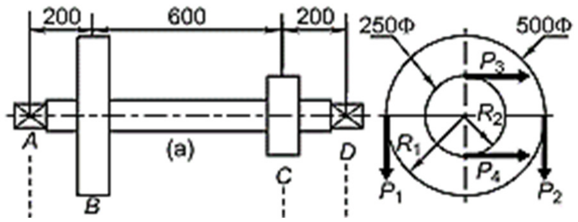

Figure 3

OR iii. A steel solid shaft transmitting 15 kW at 200 r.p.m. is supported on two bearings 750 mm apart and has two gears keyed to it as shown in figure 4. The pinion having 30 teeth of 5 mm module is located 100 mm to the left of the right hand bearing and delivers power horizontally to the right. The gear having 100 teeth of 5 mm module is located 150 mm to the right of the left hand bearing and receives power in a vertical direction from below. Using an allowable stress of 54 MPa in shear, determine the diameter of the shaft. All dimensions are in mm. **7** 03 01 03

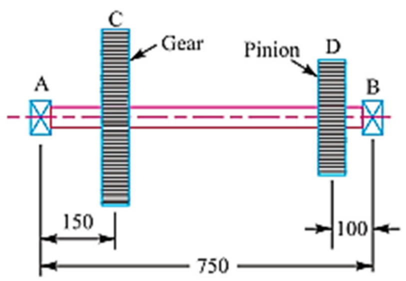

Figure 4

Total No. of Questions: 6 *Total No. of Printed Pages:6*

Enrollment No......................................

Faculty of Engineering
End Sem Examination Dec 2024
AU3CO31 Machine Design

Programme: B.Tech. Branch/Specialisation: AU

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d. Assume suitable data if necessary. Notations and symbols have their usual meaning. Design data book is permitted.

		Question	Marks	BL	PO	CO	PSO
Q.1	i.	Which theories of failure is applicable to failure of ductile materials? (a) Distortion energy theory and normal stress theory (b) Max shear stress theory and Max. normal stress theory (c) Distortion energy theory and Max shear stress theory (d) Max. normal stress theory and Coulomb's Mohr theory	**1**	01	01	01	
	ii.	For determining the endurance limit of a material, practically how many number of cycles are considered? (a) 10^4 (b) 10^6 (c) 10^8 (d) 10^{10}	**1**	01	01	01	
	iii.	Which of these keys does not require keyway on the shaft? (a) Saddle key (b) Woodruff key (c) Square (d) Flat key	**1**	01	01	02	
	iv.	The design of flat or square key is based on- (a) Shear failure of key (b) Crushing failure (c) Both (a) & (b) (d) None of these	**1**	01	01	02	
	v.	In designing shafts using ASME code the value of permissible shear stress ζ_{max}. is taken as (where, S_{yt} = Yield strength in tension)- (a) 0.30(S_{yt}) (b) 0.40(S_{yt}) (c) 0.50(S_{yt}) (d) 0.60(S_{yt})	**1**	01	01	03	

vi. Transmission shafts are designed for- **1** 01 01 03

(a) Axial loads (b) Bending moments
(c) Torsional moment (d) All of these

vii. One of the stresses considered in design of helical springs are - **1**)1 01 04

(a) Direct shear stress (b) Torsional shear stress
(c) Both (a) & (b) (d) None of these

viii. In a multi-leaf spring, the number of full-length leaves are- **1** 01 01 04

(a) 1 (b) 2 (c) 3 (d) 4

ix. The effect of centrifugal tension (T_c) in belts on causes – **1** 01 01 05

(a) Increase in power transmission
(b) Decrease in power transmission
(c) Power transmission remain unaffected
(d) Cannot say

x. Which of the two statement/s is/are true rule/s for designing of chain drive? **1** Bl01 01 05

I. The number of links in chain should be always even
II. The number of teeth in driving sprocket should be always odd

(a) Only I (b) Only II
(c) Both (a) & (b) (d) None of these

Q.2 i. Define- stress concentration and factor of safety. Give one example of each. **2** 01 01 01

ii. Explain Max. Shear stress theory with neat diagram and equation. **3** 02 01 01

iii. A plate, as shown in figure 1 is subjected to a tensile load of 20 kN. **5** 03 01 01

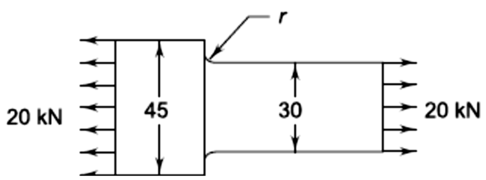

Figure 1

The plate is made of cast iron (S_{ut} = 350 N/mm^2) and the factor of safety is 2.5. If the fillet radius `r' is 3 mm, Determine the thickness of the plate.

OR iv. A plate made of steel 20C8 (S_{ut} = 440 N/mm^2) in **5** 03 01 01

hot rolled and normalised condition is shown in figure 2. It is subjected to a completely reversed axial load of 30 kN. The notch sensitivity factor q can be taken as 0.8 and the expected reliability is 90%. The size factor is 0.85. The factor of safety is 2. Determine the plate thickness for infinite life.

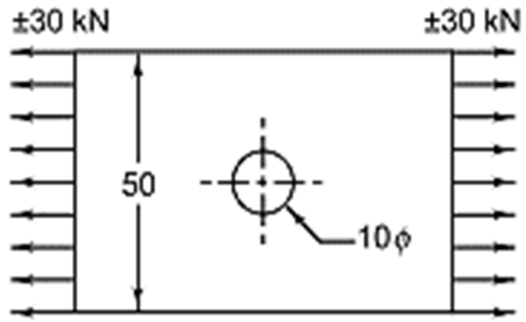

Figure 2

Q.3 i. Give classification of keys with neat sketches showing important dimensions **4** 01 01 02

ii. It is required to design a square key for fixing a gear on a shaft of 25 mm diameter. The shaft is transmitting 15 kW power at 720 rpm to the gear. The key is made of steel 50C4 (Syt = 460 N/mm^2) and the factor of safety is 3. For key material, the yield strength in compression can be assumed to be equal to the yield strength in tension. Determine the dimensions of the key. **6** 03 01 02

OR iii. Design a muff coupling which is used to connect two steel shafts transmitting 40 kW at 350 r.p.m. The material for the shafts and key is plain carbon steel for which allowable shear and crushing stresses may be taken as 40 MPa and 80 MPa respectively. The material for the muff is cast iron for which the allowable shear stress may be assumed as 15 MPa. **6** 03 01 02

Q.4 i. Explain the different types of shafts used in industrial machines. **3** 01 01 03

Q.5 i. Give classification of springs with neat sketches and applications. **4** 01 01 04

ii. It is required to design a helical compression spring subjected to a maximum force of 1250 N. The deflection of the spring corresponding to the maximum force should be approximately 30 mm. The spring index can be taken as 6. The spring is made of patented and cold-drawn steel wire. The ultimate tensile strength and modulus of rigidity of the spring material are 1090 and 81,370 N/mm^2 respectively. The permissible shear stress for the spring wire should be taken as 50% of the ultimate tensile strength. Design the spring and calculate: (a) wire diameter; (b) mean coil diameter; (c) number of active coils; (d) total number of coils; (e) free length of the spring; and (f) pitch of the coil. **6** 03 01 04

OR iii. Design a leaf spring for the following specifications: Total load = 140 kN; Number of springs supporting the load = 4; Maximum number of leaves = 10; Span of the spring = 1000 mm; Permissible deflection = 80 mm. Take Young's modulus, E = 200 kN/mm^2 and allowable stress in spring material as 600 MPa. **6** 03 01 04

Q.6 Attempt any two:

i. The layout of a leather belt drive transmitting 15 kW of power is shown in Figure 5. The centre distance between the pulleys is twice the diameter of the bigger pulley. The belt should operate at a velocity of 20 m/s approximately and the stresses in the belt should not exceed 2.25 N/mm^2. The density of leather is 0.95 g/cc and the coefficient of friction is 0.35. The thickness of the belt is 5 mm. Calculate: (a) the diameter of pulleys; (b) the length and width of the belt; & (c) the belt tensions. **5** 03 01 05

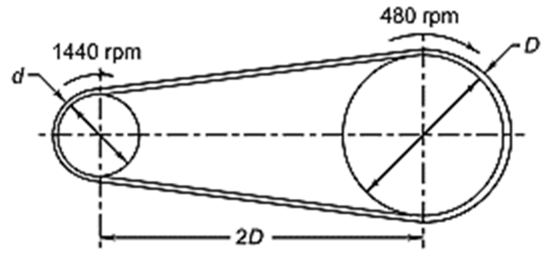

Figure 5

ii. A rope drive transmits 600 kW from a pulley of effective diameter 4 m, which runs at a speed of 90 r.p.m. The angle of lap is 160°; the angle of groove 45°; the coefficient of friction 0.28; the mass of rope 1.5 kg/m and the allowable tension in each rope 2400 N. Find the number of ropes required. **5** 03 01 05

iii. Discuss the advantages and limitations of chain drive as compared to belt drive. **5** 03 01 05

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Scheme of Marking
AU3CO31 (T) Machine Design (T)

Q.1	i)	c) distortion energy theory and Max shear stress theory	1
	ii)	b) 10^6	1
	iii)	a) Saddle key	1
	iv)	c) Both Shear failure and Crushing failure	1
	v)	a) $0.30(S_{yt})$	1
	vi)	d) All of these	1
	vii)	c) Both of these	1
	viii)	b) 2	1
	ix)	c) Power transmission remain unaffected	1
	x)	d) Both i) and ii) are correct	1
Q.2	i.	Stress Concentration 1M Factor of Safety. 1M	2
	ii.	Max. Shear stress theory 2M diagram and equation 1M	3
	iii.	Tensile stress at fillet section 2M Tensile stress at hole section 1M Thickness of plate 2M (T=3 mm)	5
OR	iv.	Endurance limit stress for plate 2M Permissible stress amplitude 2M Plate thickness 1M $s_e=50.9 \frac{N}{mm^2}$ σ_a=20.36 t-36.84 mm	5
Q.3	i.	4 keys & their diagrams $157,\frac{N}{mm^2}$ 1X4	4
	ii.	Permissible compressive and shear stresses 1M Torque transmitted by the shaft 2M Key dimensions 2M b=6 mm 1=34.6 mm	5
OR	iii.	Design of shaft, Design of sleeve, Design of key ,Shear stress and crushing stress 1X5	5
Q.4	i.	3 shafts 1x3	3
	ii.	Moments at different points 2M Load Diagrams 2M Torsional moment 2M Shaft diameter 1M d=45.7 mm	7
OR	iii.	Bending moments 2M B.M. diagrams 2M Equivalent twisting moment 2M Shaft diameter 1M	7
Q.5	i.	4 springs with diagram 1X4	4
	ii.	wire diameter; mean coil diameter; number of active coils; total number of coils; free length of the spring; and pitch of the coil d=7 mm, D= 42MM, N= ∂, ∂=30 mm 1X6	6
OR	iii.	Thickness 3M Width 3M	6
Q.6			
	i.	diameter of pulleys 2M the length and width of the belt 2M belt tensions 1M 270/810 4981 mm 130 mm $P1/P2 = 1428N/692N$	5
	ii.	Rope velocity, centrifugal tension Tc, T_1,T_2, No. of ropes n=12 1X5	5
	iii.	5 Advantages + 5 Limitations	5

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P.T.O.