Reg. No.															

Question Paper Code	13251

B.E. / B.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2024

Fifth Semester

Mechanical Engineering

20MEPC504 - DESIGN OF MACHINE ELEMENTS

Regulations - 2020

(Use of design data book is permitted)

Duration: 3 Hours Max. Marks: 100

PART - A (MCQ) (20 × 1 = 20 Marks)

Answer ALL Questions

		Marks	K – Level	CO
1.	Which design consideration deals with the appearance of the product? (a) Ergonomics (b) Aesthetics (c) System design (d) Creative design	1	K1	CO1
2.	Which of the following is not the cause of stress concentration? (a) Abrupt changes in cross-section (b) Discontinuity in the component (c) Machining scratches (d) Point load applied on the component	1	K2	CO1
3.	Which of the following materials has maximum ductility (a) grey cast iron (b) mild steel (c) alloy steel (d) high carbon steel	1	K1	CO1
4.	The bending stress in a curved beam is (a) zero at the neutral axis (b) zero at the centroidal axis (c) zero at the inner fiber (d) zero at the outer fiber	1	K1	CO1
5.	According to maximum shear stress theory of failure, the relationship between yield strength in shear (τ_y) and tensile yield strength (σ_y) is (a) $\tau_y = 0.5\ \sigma_y$ (b) $\tau_y = 0.577\ \sigma_y$ (c) $\tau_y = 0.75\ \sigma_y$ (d) $\tau_y = 0.4\ \sigma_y$	1	K1	CO2
6.	A mechanical component may fail as a result of which of the following (a) elastic deflection (b) general yielding (c) fracture (d) each of the mentioned	1	K1	CO2
7.	When using cast iron components, which of the following strength are considered to be the failure criterion? (a) Yield Strength (b) Endurance limit (c) Ultimate tensile strength (d) None of the above	1	K1	CO2
8.	The phenomenon of decreased resistance of the materials to fluctuating stresses is the main characteristic of _____ failure. (a) Fracture (b) Fatigue (c) Yielding (d) None of the above	1	K1	CO2
9.	Shafts are subjected to _____ forces. (a) Compressive (b) Tensile (c) Shear (d) None of the listed	1	K1	CO3
10.	The shafts will have same strength on the basis of torsional rigidity, if (a) diameter and length of both shafts is same (b) material of both shafts is same (c) angle of twist for both shafts is same (d) all of above conditions are satisfied	1	K1	CO3
11.	Woodruff key permits _____ movement between shaft and the hub. (a) Axial (b) Radial (c) Eccentric (d) None of the listed	1	K1	CO3
12.	Which is not a possible type of failure in a riveted joint? (a) Crushing failure of the plate (b) Shear failure of rivet (c) Tensile failure of the plate between rivets (d) Shear failure of plate	1	K1	CO4
13.	What is the requirement to weld a butt joint? (a) The components must lie in the same plane (b) The components may not necessarily lie in the same plane (c) Bevelling is not required for components with a thickness less than 5 mm (d) There is no requirement to weld a butt joint	1	K1	CO4

14.	The pin in knuckle joint is subjected to _____ stress. (a) torsional shear (b) double shear (c) axial compressive (d) axial tensile	*1*	*K1*	*CO4*
15.	Find the shear stress in the spring wire used to design a helical compression sprig if a load of 1200N is applied on the spring. Spring index is 6, and wire diameter 7mm. (a) 452.2N/mm² (b) 468.6N/mm² (c) 512.2N/mm² (d) None of the listed	*1*	*K1*	*CO5*
16.	What will happen if stresses induced due to surge in the spring exceeds the endurance limit stress of the spring. (a) Fatigue Failure (b) Fracture (c) None of the listed (d) Nipping	*1*	*K2*	*CO5*
17.	Which of the following are functions of flywheel? (a) Store and release energy during work cycle (b) Reduce power capacity of the electric motor (c) Reduce amplitude of speed fluctuations (d) All of the listed	*1*	*K1*	*CO5*
18.	A journal bearing is a _____ contact bearing working on the hydrodynamic lubrication and which supports load in____ direction. (a) Sliding, Axial (b) Rolling, Radial (c) Sliding, Radial (d) Rolling, Axial	*1*	*K2*	*CO6*
19.	The bearing is subjected to a radial load of 4000N. Expected life for 90% bearings is 9000h and shaft is rotating at 1500rpm. Calculate the dynamic load capacity. (a) 42.21kN (b) 37.29kN (c) 26.33kN (d) 35.22kN	*1*	*K1*	*CO6*
20.	There is problem of alignment in deep groove ball bearings. (a) Yes (b) It aligns itself only in some particular cases (c) No, it is self-aligning (d) Can't be determined	*1*	*K2*	*CO6*

PART - B (10 × 2 = 20 Marks)

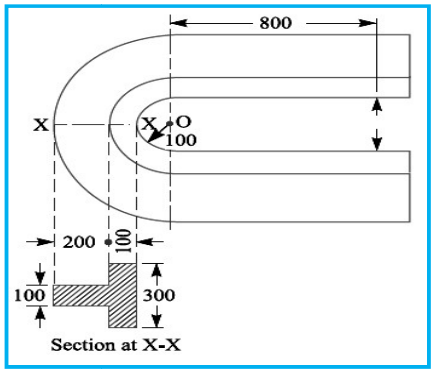
Answer ALL Questions

21.	Define fits and tolerances.	*2*	*K1*	*CO1*
22.	Define fluctuating stresses.	*2*	*K1*	*CO2*
23.	List some advantages of hollow shafts over solid shafts.	*2*	*K2*	*CO3*
24.	State the difference between rigid and flexible coupling.	*2*	*K1*	*CO3*
25.	Discuss the need for preloading of bolts.	*2*	*K2*	*CO4*
26.	List the various modes of failure of fork end in knuckle joint.	*2*	*K1*	*CO4*
27.	State the various functions of a spring. In which type of spring the behaviour is non-linear?	*2*	*K1*	*CO5*
28.	Name the stresses set up in an IC engine connecting rod.	*2*	*K1*	*CO5*
29.	List any four advantages of rolling contact bearings over sliding contact bearings.	*2*	*K1*	*CO6*
30.	Give two applications where the inner race is rotating and outer race is stationary in rolling contact bearings.	*2*	*K2*	*CO6*

PART - C (6 × 10 = 60 Marks)

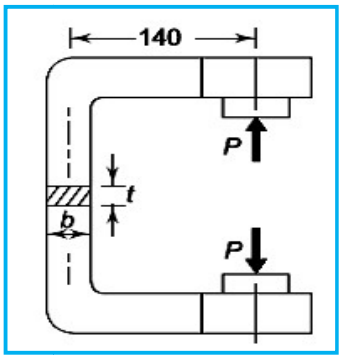
Answer ALL Questions

31.	a)	A punch press, used for stamping sheet metal, has a punching capacity of 50 kN. The section of the frame is as shown in Figure. Find the resultant stress at the inner and outer fibers of the section.	*10*	*K3*	*CO1*



OR

b) Figure shows a C-clamp, which carries a load P of 25 kN. The cross-section of the clamp is rectangular and the ratio of width to thickness (b/t) is 2:1. The clamp is made of cast steel of Grade 20-40 (S_{ut}= 400 N/mm^2) and the factor of safety is 4. Determine the dimensions of the cross-section of the clamp. *10 K3 CO1*

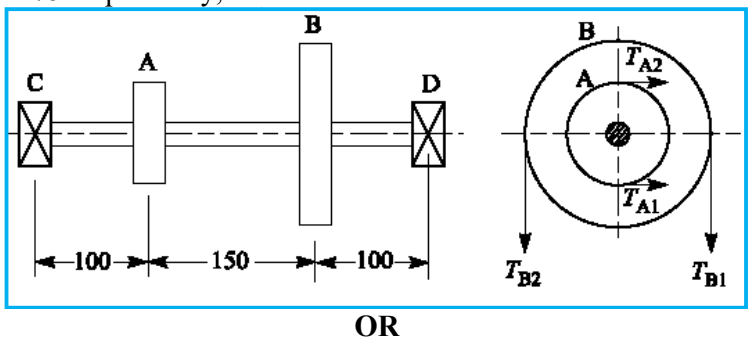


32. a) A machine component is subjected to a flexural stress which fluctuates between +300 MN/m^2 and -150 MN/m^2. Determine the value of minimum ultimate strength according to 1. Gerber relation; 2. Modified Goodman relation; and 3. Soderberg relation. Take yield strength = 0.55 Ultimate strength; Endurance strength= 0.5 Ultimate strength and factor of safety = 2. *10 K3 CO2*

OR

b) A mild steel shaft of 50 mm diameter is subjected to a bending moment of 2000 N-m and a torque T. If the yield point of the steel in tension is 200 MPa, find the maximum value of this torque without causing yielding of the shaft according to 1. The maximum principal stress theory and 2. The maximum shear stress theory. *10 K3 CO2*

33. a) The shaft, as shown in Figure, is driven by pulley B from an electric motor. Another belt drive from pulley A is running a compressor. The belt tensions for pulley A is 1500 N and 600 N. The ratio of belt tensions for pulley B is 3.5. The diameter of pulley A is 150 mm and the diameter of pulley B is 480 mm. The allowable shear stress is 85 MPa. Taking torsion and bending factors as 1.25 and 1.75 respectively, find the shaft diameter. *10 K3 CO3*



OR

b) Design a muff coupling to connect two shafts transmitting 40kW at 120 rpm. The permissible shear and crushing stress for the shaft and key material (mild steel) are 30 MPa and 80MPa respectively. The material of muff is cast iron with permissible shear stress of 15 MPa. Assume that the maximum torque transmitted is 25 per cent greater than mean torque. *10 K3 CO3*

34.	a)	Determine the length of the weld run for a plate size 120mm wide and 15mm thick to be welded to another plate by means of a) a single transverse weld and b) double fillet welds when the joint is subjected to variable load.	*10*	*K3*	*CO4*
		OR			
	b)	Design a cotter joint to connect piston rod to the crosshead of a double acting steam engine. The diameter of the cylinder is 300mm and the steam pressure is $1N/mm^2$. The allowable stresses for the material of cotter and piston rod are as follows. Tensile stress50MPa, Shear Stress 40 MPa and Compressive stress 84MPa.	*10*	*K3*	*CO4*
35.	a)	A semi-elliptical laminated spring 900 mm long and 55 mm wide is held together at the centre by a band 50mm wide. If thickness of each leaf is 5mm, find the number of leaves required to carry a load of 4500 N. Assume a maximum working stress of 490 MPa. If the two of these leaves extend the full length of the spring, find the deflection of spring. The young's modulus for the spring material may be taken as 210 kN/mm^2.	*10*	*K3*	*CO5*
		OR			
	b)	Evaluate the dimensions of an I-section connecting rod for a petrol engine from the following data: Diameter of the piston = 110 mm; Mass of the reciprocating parts = 2kg; Length of the connecting rod from the centre to centre = 325mm; Stroke length = 150mm RPM = 1500 with possible over speed of 2500; Compression ratio = 4:1; Maximum explosion pressure = 2.5 N/mm^2.	*10*	*K3*	*CO5*
36.	a)	A full journal bearing of 50 mm diameter and 100 mm long has a bearing pressure of 1.4 MPa. The speed of the journal is 900 rpm and the ratio of journal diameter to the diametrical clearance is 1000. The bearing is lubricated with oil whose absolute viscosity at the operating temperature of 75˚C may be taken as 0.011 kg/m-s. The room temperature is 35˚C. Calculate (i) The amount of artificial cooling required and (ii) The mass of the lubricating oil required, if the difference between the outlet and inlet temperature of the oil is 10˚C. Take specific heat of the oil as 1850 J/kg/˚C.	*10*	*K3*	*CO6*
		OR			
	b)	Select a single row deep groove ball bearing for a radial load of 4000N and an axial load of 5000N, operating at a speed of 1600 rpm for an average life of 5 year at 10 hours per day. Assume uniform and steady load.	*10*	*K3*	*CO6*