Roll No. | | | | | | | | | | |

ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

B.E. /B.Tech / B. Arch (Full Time) - END SEMESTER EXAMINATIONS, APR / MAY 2024

INDUSTRIAL ENGINEERING
Semester V
ME5553 & MACHINE DESIGN
(Regulation 2019)

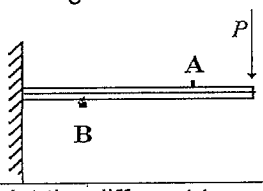
Time:3 hrs | Max.Marks: 100

(Use of PSG Design Data Book is permitted)

CO1	Design machine members subjected to static loads.
CO2	Design shafts, couplings, welded joints, riveted joints, and bearings for various applications.
CO3	Design helical springs, flywheels, connecting rods, and crankshafts for various applications.
CO4	Design flexible elements like belt, ropes, and chain drives for engineering applications.
CO5	Design spur, helical gear drives, and multi-speed gearboxes for power transmission

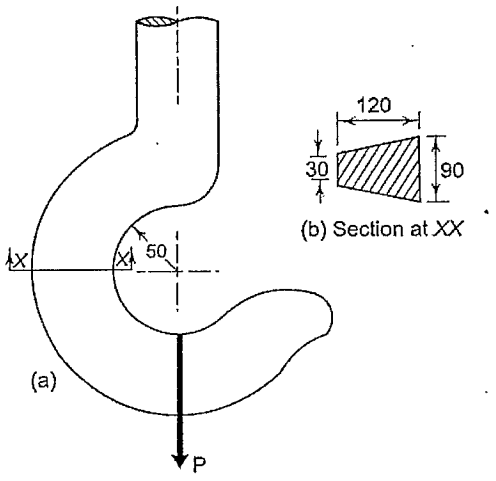
BL – Bloom's Taxonomy Levels
(L1-Remembering, L2-Understanding, L3-Applying, L4-Analysing, L5-Evaluating, L6-Creating)

PART- A (10 x 2 = 20 Marks)
(Answer all Questions)

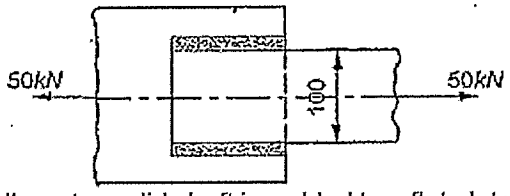
Q.No.	Questions	Marks	CO	BL
1	Define Factor of Safety.	2	CO1	BL1
2	Identify the type of stress developed at point A and Point B. Mention its magnitude. 	2	CO1	BL2
3	List the different types of key.	2	CO2	BL2
4	What is meant by flexible coupling?	2	CO2	BL1
5	What is the purpose of flywheel that is used in an IC engine?	2	CO3	BL2
6	Define spring Index and stiffness.	2	CO3	BL1
7	Write the expression for ration of tensions of flat belt drive.	2	CO4	BL1
8	List the stresses acting on rope drive.	2	CO4	BL2
9	Define Module of gear.	2	CO5	BL1
10	What is meant by ray diagram?	2	CO5	BL1

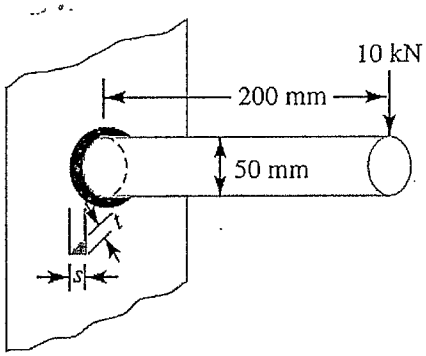
PART- B (5 x 13 = 65 Marks)
(Restrict to a maximum of 2 subdivisions)

Q.No.	Questions	Marks	CO	BL
11 (a)	A cylindrical shaft made of steel of yield strength 800 MPa is subjected to static loads consisting of bending moment 15 kN-m and a torsional moment 30 kN-m. Determine the diameter of the shaft using two different theories of failure, and assuming a factor of safety of 2. Take E = 210 GPa and poisson's ratio = 0.2.	13	CO1	BL3
	OR			
11 (b)	A crane hook having an approximate trapezoidal cross-section is shown in Figure. It is made of plain carbon steel 45C8 (S_{yt} = 380 N/mm^2) and the factor of safety is 3.5. Determine the load carrying capacity of the hook.	13	CO1	BL3



12 (a)	Design a shaft to transmit power from an electric motor to a lathe head stock through a pulley by means of a belt drive. The pulley weighs 200 N and is located at 300 mm from the centre of the bearing. The diameter of the pulley is 200 mm and the maximum power transmitted is 1 kW at 120 r.p.m. The angle of lap of the belt is 180° and coefficient of friction between the belt and the pulley is 0.3. The shock and fatigue factors for bending and twisting are 1.5 and 2.0 respectively. The allowable shear stress in the shaft may be taken as 35 MPa.	13	CO2	BL4
	OR			
12 (b)	i) A plate 100 mm wide and 12.5 mm thick is to be welded to another plate by means of two parallel fillet welds. The plates are subjected to a load of 50 kN. Find the length of the weld so that the maximum stress does not exceed 56 N/mm². (Do the calculations under static loading).	7	CO2	BL4
	ii) A 50 mm diameter solid shaft is welded to a flat plate as shown in Fig. If the size of the weld is 15 mm, find the maximum normal and shear stress in the weld.	6		





13 (a)	Design and draw a valve spring of a petrol engine for the following operating conditions: Spring load when the valve is open = 400 N Spring load when the valve is closed = 250 N Maximum inside diameter of spring = 25 mm Length of the spring when the valve is open = 40 mm Length of the spring when the valve is closed = 50 mm Maximum permissible shear stress = 400 MPa	13	CO3	BL4
	OR			
13 (b)	The areas of the turning moment diagram for one revolution of a multi-cylinder engine with reference to the mean turning moment, below and above the line, are – 32, + 408, – 267, + 333, – 310, + 226, – 374, + 260 and – 244 mm^2. The scale for abscissa and ordinate are: 1 mm = 2.4° and 1 mm = 650 N-m respectively. The mean speed is 300 r.p.m. with a percentage speed fluctuation of ± 1.5%. If the hoop stress in the material of the rim is not to exceed 5.6 MPa, determine the suitable diameter and cross-section for the flywheel, assuming that the width is equal to 4 times the thickness. The density of the material may be taken as 7200 kg / m^3. Neglect the effect of the boss and arms.	13	CO3	BL4
14 (a)	Design a flat belt drive to transmit 22kW at 740 rpm to aluminum rolling machine, The speed ration is 3.0. The distance between the centres of pulley is 3m. The diameter of aluminum rolling pulley is 1.2 m.	13	CO4	BL3
	OR			
14 (b)	A centrifugal pump running at 340 rpm is to be driven by a 100 kW motor running at 1440 rpm. The drive is to work for atleast 20 hours a day. The centre distance between motor and pump shaft is 1200 mm. Suggest a suitable v-belt drive.	13	CO4	BL3
15 (a)	Design a spur gear drive required to transmit 45 kW at a pinion speed of 800 r.p.m. The velocity ratio is 3.5:1. The teeth are 20° full depth involute with 18 teeth on the pinion. Both the pinion and gear are made of steel with a maximum safe static stress of 180 N/mm^2. Assume medium shock conditions.	13	CO5	BL4
	OR			
15 (b)	i) Design a 6 speed gear box for a minimum speed of 160 rpm and a maximum speed of 500 rpm. Draw the ray diagram. ii) Write the procedure for designing a helical gear.	5 8	CO5	BL4

PART- C(1x 15=15Marks)

(Q.No.16 is compulsory)

Q.No.	Questions	Marks	CO	BL
16.	An otto cycle engine develops 50 kW at 150 r.p.m. with 75 explosions per minute. The change of speed from the commencement to the end of power stroke must not exceed 0.5% of mean on either side. Design a suitable rim section having width four times the depth so that the hoop stress does not exceed 4 MPa. Assume that the flywheel stores 16/15 times the energy stored by the rim and that the workdone during power stroke is 1.40 times the workdone during the cycle. Density of rim material is 7200 kg/m^3.	15	CO	BL5