SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

V- SEMESTER

1909502 – DESIGN OF MACHINE ELEMENTS

Regulation – 2019

Academic Year 2022 –2023

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QUESTION BANK

SUBJECT/SUBJECT CODE :DESIGN OF MACHINE ELEMENT/1909502
SEM/YEAR :V SEM/III YEAR

UNIT I - STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS

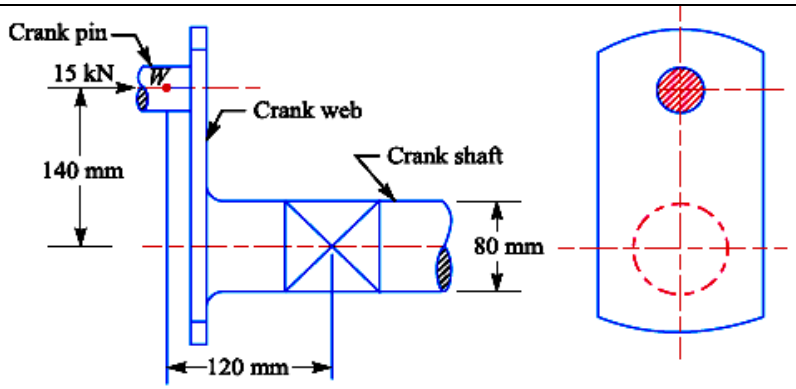
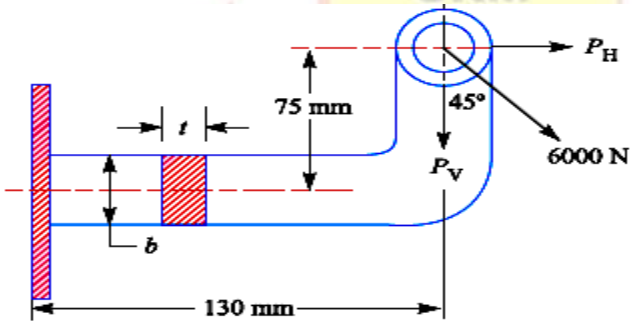
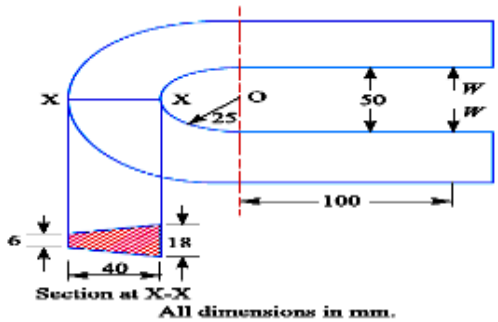
Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principle stresses for various load combinations, eccentric loading – curved beams – crane hook and 'C' frame- Factor of safety - theories of failure – Design based on strength and stiffness – stress concentration – Design for variable loading

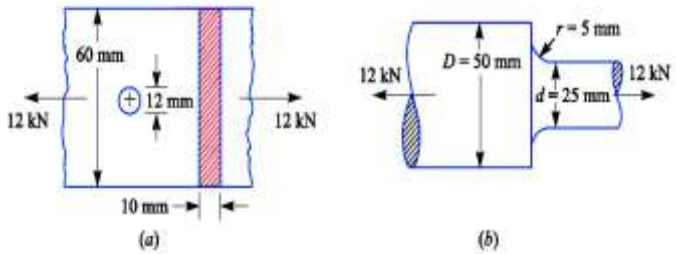
PART - A (2Marks)

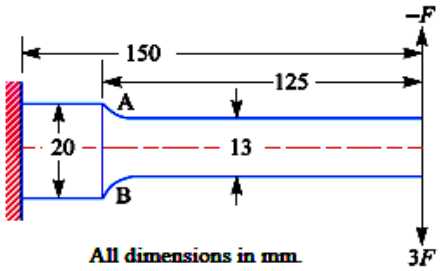
S.No	QUESTIONS	LEVEL	COMPETENCE
1.	Brief about Soderberg and Goodman lines.	BT1	Remember
2.	Define shock factor and what does it indicate	BT2	Understand
3.	Distinguish hardness and toughness.	BT1	Remember
4.	List out the various phases of design process.	BT1	Remember
5.	Define fits and tolerances. How are they designated?	BT1	Remember
6.	What do you understand by the nominal size and basic size?	BT2	Understand
7.	Define following terms a. Interchange ability b. Allowance	BT1	Remember
8.	Define "hole basic system" and "shaft basic system.	BT1	Remember
9.	What do you understand by preferred numbers?	BT2	Understand
10.	Classify the different types of loads that can act on machine components.	BT4	Analyze
11.	Describe the common materials used in mechanical engineering design.	BT1	Remember
12.	What do you understand by factor of safety?	BT2	Understand
13.	List the important factors that influence the magnitude of factor of safety.	BT1	Remember
14.	What is meant by working stress and how it is calculated from the ultimate stress or yield stress of a material?	BT1	Remember
15.	Define endurance limit.	BT1	Remember
16.	Which theory of failure is suitable for the design of brittle materials?	BT1	Remember
17.	Differentiate between repeated stress and reversed stress.	BT4	Analyze
18.	Define stress concentration and stress concentration factor.	BT1	Remember
19.	Give some methods of reducing stress concentration.	BT2	Understand
20.	Define notch sensitivity. State the relation between stress concentration factor, fatigue stress concentration factor and notch sensitivity.	BT1	Remember
21.	State the assumptions made in deriving a bending formula.	BT1	Remember

22.	Distinguish clearly between direct stress and bending stress.	BT1	Remember
23.	What is meant by eccentric loading and eccentricity?	BT1	Remember
24.	What information do you obtain from Soderberg diagram?	BT1	Remember
25.	Illustrate how the stress concentration in a component can be reduced.	BT1	Remember

	PART - B (13 Marks)			
S.No	**QUESTIONS**	**Marks**	**LEVEL**	**COMPETENCE**
1	A hypothetical machine member by 50mm in diameter and 250mm long is supported in one end as cantilever is subjected to various types of loadings as given below. Find the principal stress and maximum shear stress in each case. i. Axial load 15 KN ii. Transverse load 3KN at the free end iii. Twisting moment of 1KN-m at the free end, clockwise, while viewing from free end side iv. (i) and (ii) together v. (i) (ii) and (iii) together	13	BT5	Evaluate
2	A hollow shaft of 40mm outer diameter and 25mm inner diameter is subjected to a twisting moment of 120 N-m simultaneously; it is subjected to an axial thrust of 10kN and a bending moment of 80 N-m. Calculate the maximum compressive and shear stresses.	13	BT3	Apply
3	An overhang crank with pin and shaft is shown in Fig 1.1. A tangential load of 15kN acts on the crank pin. Determine the maximum principal stress and the maximum shear stress at the centre of the crankshaft bearing	13	BT5	Evaluate

	 Fig 1.1			
4	A mild steel bracket as shown in Fig 1.2. is subjected to a pull of 6000N acting at 45˚ to its horizontal axis. The bracket has a rectangular section whose depth is twice the thickness. Determine the cross-sectional dimensions of the bracket, if the permissible stress in the materials of the bracket is limited to 60 MPa.  Fig 1.2	13	BT5	Evaluate
5	(a) The frame of a punch press is shown in fig 1.3. Find the stress at the inner and outer surface at section X-X of the frame, if W=5000N.  Fig 1.3	10+3	BT5	Evaluate

	b. what is factor of safety? List the factors to be considered while deciding the factor of safety.			
6	The load on a bolt consists of an axial pull of 10kN together with a transverse shear force of 5kN. Find the diameter of bolt required according to 1. Maximum principle stress theory 2. Maximum shear stress theory; 3. Maximum principle strain theory; 4. Maximum strain energy theory; and 5. Maximum distortion energy theory. Take permissible tensile stress at elastic limit = 100 MPa and Poisson's ratio = 0.3.	13	BT1	Remember
7	A mild steel shaft of 50mm 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, Calculate the maximum value of this torque without causing yielding of the shaft according to 1. The Maximum principle stress; 2. The maximum shear stress and 3. The maximum distortion strain energy theory of yielding.	13	BT5	Evaluate
8	Calculate the maximum stress induced in the following cases taking stress concentration into account: 1. A rectangular plate 60 mm × 10 mm with a hole 12 diameter as shown in Fig 1.3. (a) and subjected to a tensile load of 12 kN. 2. A stepped shaft as shown in Fig 1.3. (b) and carrying a tensile load of 12 kN.  Fig 1.3	13	BT3	Apply
9	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	13	BT3	Apply

	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	A bar of circular cross-section is subjected to alternating tensile forces varying from a minimum of 200kN to maximum of 500kN. It is to be manufactured of a material with an ultimate tensile strength of 900MPa. and an endurance limit of 700 MPa. Determine the diameter of bar using safety factors of 3.5 Related to ultimate tensile strength and 4 related to endurance limit and a stress concentration factor of 1.65 for fatigue load. Use Goodman straight line as basis for design.	13	BT5	Evaluate
11	A circular bar of 500mm length is supported freely at its two ends. It is acted upon by a central concentrated cyclic load having a minimum value of 20kN and a maximum value of 50kN. Determine the diameter of bar by taking a factor of safety of 1.5, size effect of 0.85, surface finish of 0.9. The material properties of bar are given by ultimate strength of 650 MPa, yield strength of 500 MPa and endurance strength of 350 MPa.	13	BT5	Evaluate
12	A cantilever beam made of cold drawn carbon steel of circular cross-section as shown in fig. is subjected to a load which varies from –F to 3F. Determine the maximum load that this member can withstand for an indefinite life using a factor of safety as 2. The theoretical stress concentration factor is 1.42 and the notch sensitivity is 0.9. Assume the following values: Ultimate stress = 550 MPa. Yield Stress = 470 MPa. Endurance limit = 275 MPa. Size factor = 0.85. Surface finish factor = 0.89.  Fig 1.4	13	BT5	Evaluate

13	A pulley is keyed to a shaft midway between two bearings. The shaft is made of cold drawn steel for which the ultimate strength is 550 MPa and the yield strength is 400 MPa. The bending moment at the pulley varies from -150N.m to +400 N.m as the torque on the shaft varies from -50N.m to 150 N.m. Obtain the diameter of the shaft for an indefinite life. The stress concentration factors for the keyway at the pulley in bending and in torsion are 1.6 and 1.3 respectively. Take the following values. Factor of safety=1.5, Load correction factors=1 and 0.6 in torsion, size effect factor=0.85 and surface effect factor=0.88 .	13	BT5	Evaluate
14	A steel rod is subjected to a reversed axial load of 180KN.Find the diameter of the rod for a factor of safety of 2. Neglect the column effect. The material has an ultimate tensile strength of 1070 MPa and yield strength of 910 MPa. The endurance limit in reversed bending may be assumed to be one half of the ultimate strength. Other correction factors may be taken as follows. For axial loading=0.7, For machined surface=0.8, For size=0.85, For stress concentration=1.0	13	BT5	Evaluate
15	A rotating shaft of 16 mm diameter is made of plain carbon steel. It is subjected to axial load of 5000 N, a steady torque of 50 N-m and maximum bending moment of 75 N-m. Calculate the factor of safety available based on 1. Maximum normal stress theory; and 2. Maximum shear stress theory. Assume yield strength as 400 MPa for plain carbon steel. If all other data remaining same, what maximum yield strength of shaft material would be necessary using factor of safety of 1.686 and maximum distortion energy theory of failure. Comment on the result you get.	13	BT5	Evaluate
16	A shaft is supported in bearings, the distance between their centres being 1 metre. It carries a pulley in the centre and it weighs 1 kN. Find the diameter of the shaft, if the permissible bending stress for the shaft material is 40 MPa.	13	BT5	Evaluate

17	A steel connecting rod is subjected to a completely reversed axial load of 160 kN. Suggest the suitable diameter of the rod using a factor of safety 2. The ultimate tensile strength of the material is 1100 MPa, and yield strength 930 MPa. Neglect column action and the effect of stress concentration.	13	BT5	Evaluate
18	Find the diameter of a shaft to transmit twisting moments varying from 800 N-m to 1600 N-m. The ultimate tensile strength for the material is 600 MPa and yield stress is 450 MPa. Assume the stress concentration factor = 1.2, surface finish factor = 0.8 and size factor = 0.85.	13	BT5	Evaluate
	PART-C (15 Marks)			
1	(i) Which theory is in better agreement for predicting the failure of ductile component? Sketch the schematic representation under bi-axial stresses for the theory. (ii) What is mean by safety factor? (iii) Justify that the wheelchair design in a multidisciplinary endeavor.	15	BT6	Create
2	A steel shaft is subjected to completely reverse bending moment of 800 N-m and a cyclic twisting moment of 500 N-m which varies over a range of ±40%. Determine the diameter of shaft if a reduction factor of 1.2 is applied to the variable component of bending stress and shearing stress. Assume a) that the maximum bending and shearing stresses are in phase b) that the tensile yield point is the limiting stress for steady state component c) that the maximum shear strength theory can be applied and d) that the Goodman relation is valid take following material properties: Yield strength = 500 MPa; Ultimate strength = 800 MPa; Endurance limit = ±400 MPa.	15	BT5	Evaluate
3	Determine the diameter of a circular rod made of ductile material with a fatigue strength (complete stress reversal) σ_e = 280 MPa. and a tensile yield strength of 350 MPa. the member is subject to a varying axial load from 700 kN to -300kN. Assume K_t = 1.8 and	15	BT6	Create

	F.S =2			
4	Find the diameter of a shaft to transmit twisting moment varying from 800 N-m to 1600 N-m. The ultimate tensile strength for the material is 600 MPa. and yield stress is 450 MPa. Assume the stress concentration factor = 1.2; surface finish factor = 0.8 and size factor = 0.85.	15	BT5	Evaluate
5	A simply supported shaft between bearings carries a steady load of 10 kN at the centre. The length of shaft between bearings is 450 mm. Neglecting the effect of stress concentration, find the minimum diameter of shaft. Given that Endurance limit = 600 MPa; surface finish factor = 0.87; size factor = 0.85; and factor of safety = 1.6.	15	BT5	Evaluate

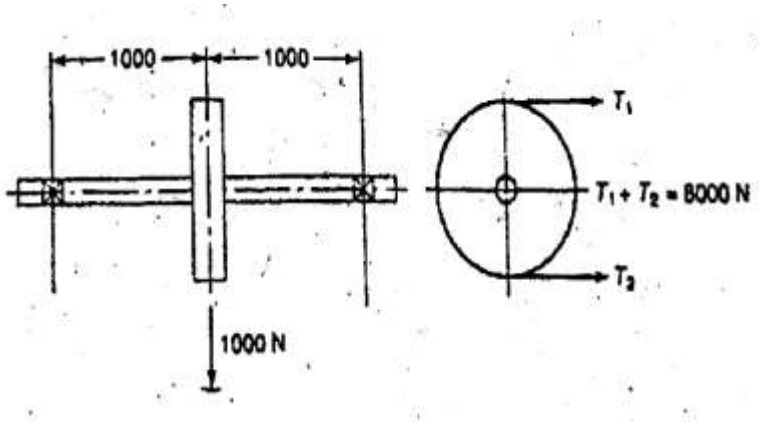
UNIT II - SHAFTS AND COUPLINGS

Design of solid and hollow shafts based on strength, rigidity and critical speed – Keys, keyways and splines - Rigid and flexible couplings.

PART - A (2Marks)

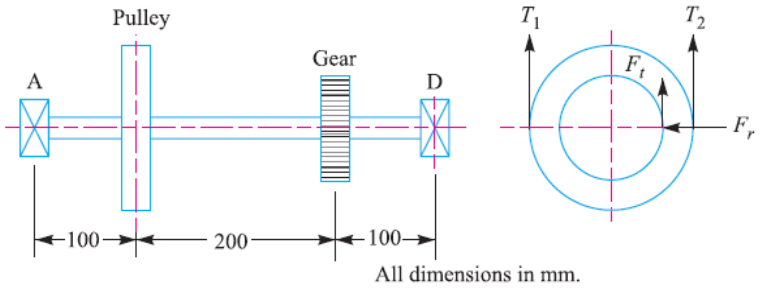
S.No	QUESTIONS	LEVEL	COMPETENCE
1.	Distinguish clearly, giving examples between pin, axle and shaft.	BT2	Understand
2.	Describe how the shafts are formed.	BT1	Remember
3.	Discuss the various types of shafts and the standard sizes of transmissions shafts	BT1	Remember
4.	List out types of stresses are induced in shafts.	BT1	Remember
5.	Point out, how the shaft is designed when it is subjected to twisting moment only?	BT1	Remember
6.	Define equivalent twisting moment and equivalent bending moment. State when these two terms are used in design of shafts.	BT1	Remember
7.	When the shaft is subjected to fluctuating loads, what will be the equivalent twisting moment and equivalent bending moment?	BT1	Remember
8.	What do you understand by torsional rigidity and lateral rigidity	BT2	Understand
9.	A hollow shaft has greater strength and stiffness than solid shaft of equal weight. Explain.	BT4	Analyze
10.	Under what circumstances are hollow shaft preferred over solid shafts?	BT2	Understand
11.	Differentiate between rigid and flexible couplings.	BT2	Understand
12.	List the different types of sunk keys and draw any one.	BT3	Apply
13.	Explain how is the strength of a shaft affected by the keyway?	BT2	Understand
14.	Discuss forces on keys.	BT1	Remember
15.	Differentiate between keys and splines.	BT1	Remember
16.	What are the considerations in the design of dimensions of formed and parallel key having rectangular cross-section?	BT1	Remember
17.	What are possible modes of failure of the pin (bolt) in a flexible coupling? Explain.	BT2	Understand
18.	Discuss the function of a coupling. Give at least three practical applications.	BT2	Understand
19.	Why are two universal joints often used when there is angular misalignment between two shafts?	BT2	Understand
20.	Under what circumstances flexible couplings are used?	BT2	Understand
21.	How does the working of a clamp coupling differ from that of a muff coupling?	BT2	Understand
22.	Give at least three practical applications of coupling.	BT2	Understand
23.	What is the effect of keyway cut into the shaft?	BT2	Understand
24.	What is a key? State its function.	BT2	Understand
25.	How are the keys classified?	BT2	Understand

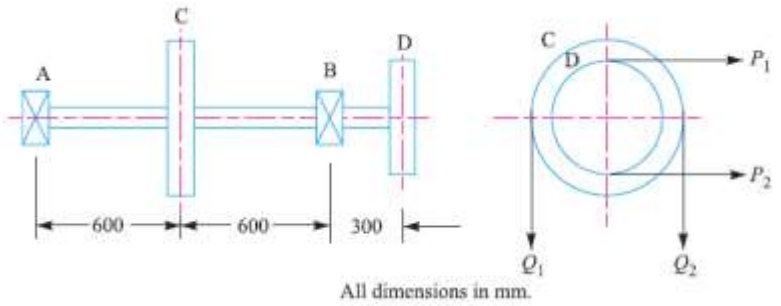
	PART - B (13 Marks)			
S.No	**QUESTIONS**	**Marks**	**LEVEL**	**COMPETENCE**
1	A mild steel shaft transmits 20kW at 200 rpm. It carries a central load of 900N and is simply supported between the bearings 2.5m apart. Determine the size of the shaft, if the allowable shear stress is 42 MPa and the maximum tensile or compressive stress is not to exceed 56MPa.What size of the shaft will be required, if it is subjected to gradually applied loads?	13	BT5	Evaluate
2	A shaft is supported by two bearings placed 1m apart. A 600mm diameter pulley is mounted at a distance of 300mm to the right of left hand bearing and this drives a pulley directly below it with the help of belt having maximum tension of 2.25kN. another pulley 400mm diameter is placed 200mm to the left of right hand bearing and is driven with the help of electric motor and belt, which is placed horizontally to the right. The angle of contact for both the pulleys is 180˚ and $\mu = 0.24$. Determine the suitable diameter for a solid shaft, allowing working stress of 63 MPa in tension and 42 MPa in shear for the material of shaft. Assume that the torque on one pulley is equal to that on the other pulley.	13	BT3	Apply
3	A shaft is supported on bearing A and B, 800 mm between centers. A 20˚ straight tooth spur gear having 600mm pitch diameter, is located 200 mm to the right of the left had bearing A, and a 700 mm diameter pulley is mounted 250 mm towards the left of bearing B. The gear is driven by a pinion with a downward tangential force while the pulley drives a horizontal belt having 180˚ angle of wrap. The pulley also serves as a flywheel and weights 2000N. The maximum belt tension is 3000 N and the tension ratio is 3:1. Determine the maximum bending moment and the necessary shaft diameter if the allowable shear stress of the material is 40 MPa.	13	BT3	Apply

4	A steel solid shaft transmitting 15kW at 200 rpm is supported on two bearing 750 mm apart and has two gears keyed to it. The pinion having 30 teeth of 5mm 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 5mm module is located 150mm to the right of the left hand bearing and receives the power in vertical direction below. Using an allowable stress of 54MPa in shear, determine the diameter of the shaft.	13	BT5	Evaluate
5	A hollow shaft of 0.5m outside diameter and 0.3m inside diameter is used to drive a propeller of a marine vessel. The shaft is mounted on bearings 6m apart and it transmits 5600kW at 150 rpm. The maximum axial propeller shaft is 500kN and the shaft weighs 70kN.Determine (i).The maximum shear stress developed in the shaft (ii).The angular twist between the bearings.	13	BT3	Apply
6	A section of commercial shafting 2m long between bearings carries a 1000N pulley at its midpoint as shown in fig. The pulley is keyed to the shaft and receives 30 KW at 150 rev/min which is transmitted to a flexible coupling just outside the right bearing. the belt drive is horizontal and some of the belt tensions is 8000 N. Assume $K_t = K_b = 1.5$. Calculate the necessary shaft diameter and determine the angle of twist between bearings. G=80 GN/m^2.  Fig 2.1	13	BT5	Evaluate
7	Design a shaft to transmit power from an electric motor to a lathe	13	BT6	Create

	head stock through a pulley be means of a belt drive. The pulley weights 200N 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 rpm. The angle 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.			
8	A shaft mad of AISI 1030 cold drawn steel transmits 50 KW at 900 rpm through a gear. select and appropriate square key for the gear.	13	BT6	Create
9	Design and make a neat dimensioned sketch of muff coupling which is used to connect two steel shafts transmitting 40kW at 350 rpm.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.	13	BT6	Create
10	Design a cast iron protective type flange coupling to transmit 15kW at 900 rpm from an electric motor to a compressor. The service factor may be assumed s 1.35.The following permissible stresses may be used. Shear stress for shaft, bolt and key material=40MPa,Crushing stress for bolt and key=80 MPa, Shear stress for cast iron=8 MPa.	13	BT3	Apply
11	Design a cast iron flange coupling for a mild steel shaft transmitting 90 kW at 250 rpm, the allowable shear stress in the shaft is 40 MPa and the angle of twist is not to exceed 1˚ in a length of 20 meters. The allowable shear stress in the coupling bolt is 30 MPa. Take G = 84 kN/mm^2	13	BT6	Create
12	Two 35 mm shaft are connected by a flanged coupling. The flanges are fitted with 6 bolts on 125 mm bolt circle. The shafts transmit a torque of 800 N-m at 350 rpm. For the safe stresses mentioned below, calculate 1. Diameter of bolts; 2. Thickness of flanges; 3. Key dimensions; 4. Hub length; and 5. Power transmitted. Safe	13	BT3	Apply

	shear stress for the shaft material = 63 MPa; Safe stress for bolt material = 56 MPa; Safe stress for cast iron coupling = 10 MPa; Safe stress for key material = 46 MPa.			
13	Design a bushed-pin type of flexible coupling to connect a pump shaft to a motor shaft transmitting 32kW at 960 rpm. The overall torque is 20% more than mean torque. The material properties are as follows. The allowable shear and crushing stress for the shaft and key material is 40 MPa and 80 MPa. The allowable shear stress for cast iron is 15 MPa. The allowable bearing pressure for rubber bush is 0.8N/mm^2.The material of the pin is same as that of shaft and key.	13	BT6	Create
14	Design and draw a protective type of cast iron flange coupling for a steel shaft transmitting 15kW at 200 rpm and having an allowable shear stress of 40 MPa. The working stress in the bolts should not exceed 30 MPa. Assume that the same material is used for the shaft and key and that the crushing stress is twice the value of its shear stress. The maximum torque is 25% greater than the full load torque. The shear stress for cast iron is 14 MPa.	13	BT6	Create
15	Design a bushed-pin type flexible coupling for connecting a motor shaft to a pump shaft for the following service conditions : Power to be transmitted = 40 kW ; speed of the motor shaft = 1000 r.p.m. ; diameter of the motor shaft = 50 mm ; diameter of the pump shaft = 45 mm.	13	BT5	Evaluate
16	Design a compression coupling for a shaft to transmit 1300 N-m. The allowable shear stress for the shaft and key is 40 MPa and the number of bolts connecting the two halves are 4. The permissible tensile stress for the bolts material is 70 MPa. The coefficient of friction between the muff and the shaft surface may be taken as 0.3.	13	BT5	Evaluate
17	A mild steel shaft transmits 15 kW at 210 r.p.m. It is supported on two bearings 750 mm apart and has two gears keyed to it. The pinion having 24 teeth of 6 mm module is located 100 mm to the left of the right hand bearing and delivers the power horizontally to the right. The gear having 80 teeth of 6 mm module is located 15	13	BT5	Evaluate

	mm to the right of the left hand bearing and receives power in a vertical direction from below. Assuming an allowable working shear stress as 53 MPa, and a combined shock and fatigue factor of 1.5 in bending as well as in torsion, determine the diameter of the shaft.			
18	A steel shaft 800 mm long transmitting 15 kW at 400 r.p.m. is supported at two bearings at the two ends. A gear wheel having 80 teeth and 500 mm pitch circle diameter is mounted at 200 mm from the left hand side bearing and receives power from a pinion meshing with it. The axis of pinion and gear lie in the horizontal plane. A pulley of 300 mm diameter is mounted at 200 mm from right hand side bearing and is used for transmitting power by a belt. The belt drive is inclined at 30° to the vertical in the forward direction. The belt lap angle is 180 degrees. The coefficient of friction between belt and pulley is 0.3. Design and sketch the arrangement of the shaft assuming the values of safe stresses as : τ = 55 MPa; σt = 80 MPa. Take torsion and bending factor 1.5 and 2 respectively.	13	BT5	Evaluate
	PART-C (15 Marks)			
1	A shaft made of steel receives 7.5 kW power at 1500 rpm. A pulley mounted on the shaft as shown in fig. has ratio of belt tension 4. The gear forces are follows F_t = 1590N; F_r = 580 N Design the shaft diameter by maximum shear stress theory. The shaft material has the following properties. Ultimate tensile strength = 720 MPa; Yield strength = 380 MPa; Factor of safety = 1.5  Fig 2.2	15	BT5	Evaluate

2	A horizontal shaft AD supported in bearings at A and B and carrying pulleys at C and D is to transmit 75 kW at 500 rpm from drive pulley D to off-take pulley C as shown in fig. calculate the diameter of shaft. The data given is $P_1 = 2P_2$ (both horizontal) $Q_1 = 2\ Q_2$ (both vertical) radius of pulley C = 220 mm, radius of pulley D = 160mm allowable shear stress = 45 MPa.  Fig 2.3	15	BT5	Evaluate
3	A marine type flange coupling is used to transmit 3.75 MW at 150 rpm. The allowable shear stress in the shaft and bolts may be taken as 50 MPa. Determine the shaft diameter and the diameter of the bolts.	15	BT5	Evaluate
4	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.	15	BT6	Create
5	A machine shaft, supported on bearings having their centres 750 mm apart, transmitted 185 kW at 600 r.p.m. A gear of 200 mm and 20° tooth profile is located 250 mm to the right of left hand bearing and a 450 mm diameter pulley is mounted at 200 mm to right of right hand bearing. The gear is driven by a pinion with a downward tangential force while the pulley drives a horizontal belt having 180° angle of contact. The pulley weighs 1000 N and tension ratio is 3. Find the diameter of the shaft, if the allowable shear stress of the material is 63 MPa.	15	BT5	Evaluate

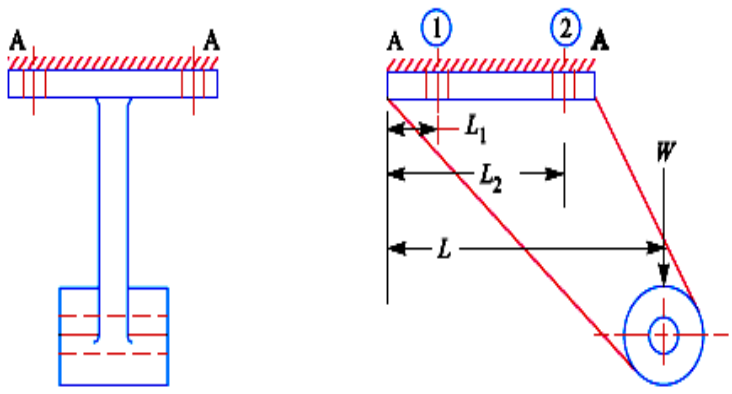
UNIT III - TEMPORARY AND PERMANENT JOINTS

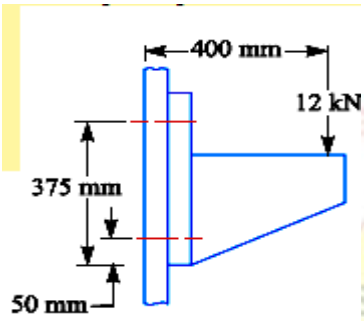
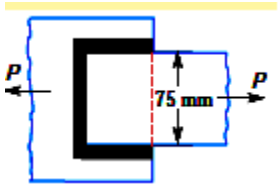
Threaded fastners - Bolted joints including eccentric loading, Knuckle joints, Cotter joints – Welded joints, riveted joints for structures - theory of bonded joints-riveted joints

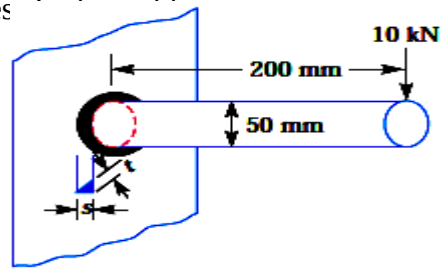
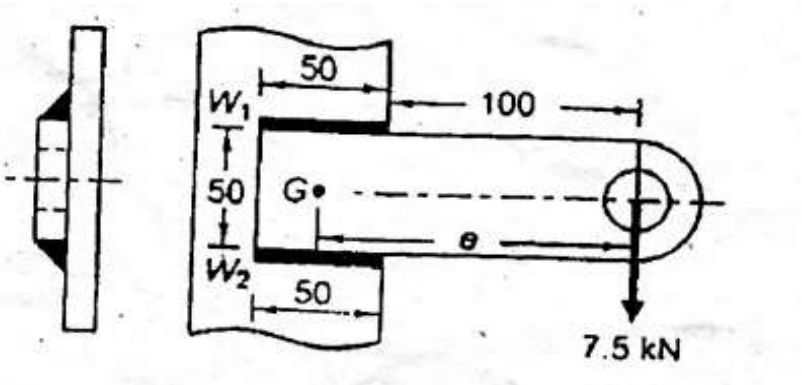
PART - A (2Marks)

S.No	QUESTIONS	LEVEL	COMPETENCE
1.	Explain how is a bolt designated?	BT1	Remember
2.	Discuss, why are ACME treads preferred over square thread for power screw?	BT2	Understand
3.	What do you understand preloading of bolts?	BT2	Understand
4.	Explain the meaning of bolt M24 x 2.	BT1	Remember
5.	What do you understand by the single start and double start threads?	BT2	Understand
6.	Which type of thread would you suggest for the following? a. Lead screw for a lathe b. Fastening of a bracket to a wall c. Screw jack.	BT5	Evaluate
7.	What is known as "bolt of uniform strength"?	BT1	Remember
8.	List out the materials used for rivets.	BT1	Remember
9.	What do you understand by the term efficiency of a riveted joint?	BT2	Understand
10.	What do you understand by the term welded joint?	BT1	Remember
11.	What is the total shear in a double strap butt joint with equal length of straps?	BT1	Remember
12.	Differentiate with a neat sketch the fillet welds subjected to parallel loading.	BT4	Analyze
13.	What is the minimum size for fillet weld? If required weld size from strength consideration is too small how will you fulfill the condition of minimum weld size?	BT6	Create
14.	What are the advantages of welded joints compared with riveted joints?	BT5	Evaluate
15.	List out the different types of cotter joints?	BT1	Remember
16.	Distinguish between cotter joint and knuckle joint.	BT2	Understand
17.	List out the various applications of a cottered joint.	BT1	Remember
18.	Why gibs are used in a cotter joint? Explain	BT1	Remember
19.	Name the possible modes of failure of riveted joint.	BT1	Remember
20.	What is a cotter joint? Explain with the help of a neat sketch, how a cotter joint is made?	BT1	Remember
21.	What are the various permanent and detachable fastenings?	BT2	Understand
22.	Enumerate the different types of riveted joints and rivets.	BT2	Understand
23.	What is an economical joint and where does it find applications?	BT2	Understand

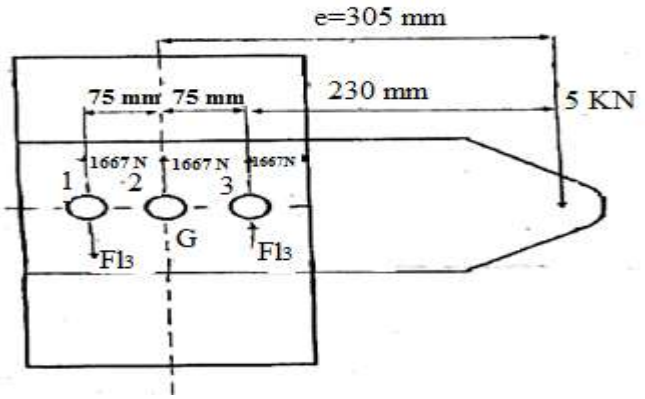
24.	What do you understand by the term 'efficiency of a riveted joint'?	BT2	Understand
25.	What is an eccentric riveted joint?	BT2	Understand

	PART - B (13 Marks)			
S.No	**QUESTIONS**	**Marks**	**LEVEL**	**COMPETENCE**
1	A steam engine cylinder of 300mm effective diameter is subjected to a steam pressure of 1.5 MPa. The cylinder head is connected by means of 8 bolts having strength of 330 MPa. and endurance limit of 240 MPa. The bolts are tightened with an initial preload of 1.5 times that of steam load. A soft copper gasket is used to make the joint leak proof assuming a factor of safety of 2; determine the size of the bolts required. The stiffness factor for copper gasket may be taken as 0.5	13	BT3	Apply
2	A mild steel cover plate is to be designed for an inspection hole in the shell of a pressure vessel. The hole is 120mm in diameter and the pressure inside the vessel is 6N/mm^2.Design the cover plate along with the bolts. Assume allowable tensile stress for mild steel as 60 MPa and for bolt material as 40 MPa.	13	BT3	Apply
3	A bracket as shown in fig 3.1. supports a load of 30kN. Determine the size of bolts, if the maximum allowable tensile stress in the bolt material is 60 MPa. the distances are: L_1 = 80 mm, L_2 = 250 mm and L = 500mm  Fig 3.1	13	BT3	Apply

4	For supporting the travelling crane in a workshop, the brackets are fixed on steel columns as shown in fig. The maximum load that comes on the bracket is 12kN acting vertically at a distance of 400 mm from the face of the column. The vertical face of the bracket is secured to a column by four bolts, in two rows (two in each row) at a distance of 50 mm from the lower edge of the bracket; determine the size of the bolts if the permissible value of the tensile stress for the bolt material is 84 MPa. Also find the cross-section of the arm of the bracket which is rectangular  Fig 3.2	13	BT3	Apply
5	A plate 75 mm wide and 12.5 mm thick is joined with another plate by a single transverse weld and a double parallel fillet weld as shown in fig. The maximum tensile and shear stress are 70 MPa and 56 MPa respectively. Calculate the length of each parallel fillet weld if the joint is subjected to both static and fatigue loading.  Fig 3.3	13	BT3	Apply

6	A 50mm diameter solid shaft is welded to a flat plate as shown in fig 3.4. if the size of the weld is 15 mm; Calculate the maximum normal and shear stres  Fig 3.4	13	BT5	Evaluate
7	(i).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 b).Double parallel fillet welds when the joint is subjected to variable loads. (ii).A plate 100 mm wide and 12.5mm thick is to be welded to another plate by means of parallel fillet welds. The plates are subjected to a load of 50kN.Find the length of the weld so that the maximum stress does not exceed 56 MPa. Consider the joint first under static loading and then under fatigue loading.	13	BT5	Evaluate
8	A welded connection as shown in fig 3.5. below is subjected to an eccentric force of 7.5KN. Determine the size of welds if the permissible shear stress for the weld is 100 N/mm^2. Assume static conditions.  Fig 3.5	13	BT5	Evaluate

9	Design and draw a cotter joint to support a load varying from 30kN in compression to 30kN in tension. The material used is carbon steel for which the following allowable stress may be used. The load is applied statically. Tensile stress = compressive stress = 50 MPa; Shear stress = 35 MPa and crushing stress = 90 MPa.	13	BT5	Evaluate
10	Design a sleeve and cotter joint to resist a tensile load of 60 kN. All parts of the joint are made of the same material with the following allowable stresses: σ_t = 60 MPa; τ=70 MPa; and σ_c = 125 MPa.	13	BT5	Evaluate
11	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 stress=50MPa, Shear Stresses=40 MPa, Compressive stresses=84MPa.	13	BT5	Evaluate
12	Design a knuckle joint for a tie rod of a circular cross section to sustain a maximum pull of 70kN.The ultimate, strength of the material of the rod against tearing is 420 Mpa. The ultimate tensile and shearing strength of the pin material are 510 MPa and 396 MPa respectively. Determine the tie rod section and pin section. Take factor of safety=6.	13	BT5	Evaluate
13	Design a knuckle joint to transmit 150 kN. The design stresses may be taken as 75 MPa. in tension, 60 MPa in shear and 150 MPa in compression.	13	BT5	Evaluate
14	Design a gib and cotter joint to carry a maximum load of 35kN.Assuming that the gib and cotter are of same material and have the following allowable stresses. σ_t = 20 MPa; τ=15 MPa; and σ_c = 50 MPa.	13	BT5	Evaluate
15	A single riveted lap joint is made in 15 mm thick plates with 20 mm diameter rivets. Determine the strength of the joint, if the pitch of rivets is 60 mm. Take σt = 120 MPa; τ = 90 MPa and σc = 160 MPa	13	BT5	Evaluate
16	A double riveted lap joint with chain riveting is to be made for	13	BT5	Evaluate

	joining two plates 10 mm thick. The allowable stresses are : σt = 60 MPa ; τ = 50 MPa and σc = 80 MPa. Find the rivet diameter, pitch of rivets and distance between rows of rivets. Also find the efficiency of the joint.			
17	A triple riveted lap joint with zig-zag riveting is to be designed to connect two plates of 6 mm thickness. Determine the dia. of rivet, pitch of rivets and distance between the rows of rivet. Indicate how the joint will fail. Assume : σt = 120 MPa ; τ = 100 MPa and σc = 150 MPa	13	BT5	Evaluate
18	Design a double riveted double strap butt joint for the longitudinal seam of a boiler shell, 750 mm in diameter, to carry a maximum steam pressure of 1.05 N/mm2 gauge. The allowable stresses are: σt = 35 MPa; τ = 28 MPa and σc = 52.5 MPa Assume the efficiency of the joint as 75%.	13	BT5	Evaluate
	PART-C (15 Marks)			
1	Specify the size and number of studs required to fasten the head of a 400 mm diameter cylinder containing steam at 2 N/mm^2. A hard gasket (gasket constant =0.3) is used in making the joint. Draw a neat sketch of the joint also. Other data may be assumed.	15	BT5	Evaluate
2	A steel plate is subjected to a force of 5KN and fixed to a channel by means of 3 identical bolts as shown in figure. The bolts are made from plain carbon steel for which yield stress in tension is 380 N/mm^2 and factor of safety is 3. Determine the size of the bolts.  Fig 3.6	15	BT5	Evaluate

3	Two mild steel rods 40mm diameter are to be connected by cotter joint. The thickness of the cotter is 12mm. Calculate the dimensions of the joint, if the maximum permissible stresses are 46 MPa; in tension 35MPa; in shear and 70 MPa in crushing.	15	BT5	Evaluate
4	Design a cotter joint to connect a piston rod to the crosshead. The maximum steam pressure on the piston rod is 35 kN. Assuming that the all parts are made of the same material having the following permissible stress: σ_1= 50MPa; τ = 60 MPa; σ = 90 MPa.	15	BT6	Create
5	Two mild steel tie bars for a bridge structure are to be joined by a double cover butt joint. The thickness of the tie bar is 20 mm and carries a tensile load of 400 kN. Design the joint if the allowable stresses are : σt = 90 MPa ; τ = 75 MPa and σc = 150 MPa. Assume the strength of rivet in double shear to be 1.75 times that of in single shear	15	BT5	Evaluate

UNIT IV - ENERGY STORING ELEMENTS AND ENGINE PERMANENT JOINTS

Various types of springs, optimization of helical springs - rubber springs - Flywheels considering stresses in rims and arms for engines and punching machines- Connecting Rods and crank shafts.

PART - A (2Marks)

S.No	QUESTIONS	LEVEL	COMPETENCE
1.	Describe the type of spring is used to maintain an effective contact between a cam and a reciprocating roller or flat faced follower?	BT2	Understand
2.	List out the various function of a spring. In which type of sprig the behaviour is non-linear?	BT1	Remember
3.	The extension springs are in considerably less use than the compression springs. Why?	BT5	Evaluate
4.	While designing helical springs K is introduced in the shear stress equation, why?	BT1	Remember
5.	What do you understand stiffness of spring?	BT2	Understand
6.	Discuss any one method of avoiding the tendency of a compression spring to buckle.	BT2	Understand
7.	What do you understand by full length and graduated leaves of a leaf spring?	BT2	Understand
8.	What is nipping in a leaf spring? Discuss its role.	BT2	Understand
9.	Define surge in a spring.	BT1	Remember
10.	Discuss the utility of the centre bolt, U- clamp, rebound clip and camber in a leaf spring.	BT2	Understand
11.	List out the main function of a flywheel in an engine?	BT1	Remember
12.	In what way does a flywheel differ from that of a governor?	BT5	Evaluate
13.	Define coefficient of fluctuation of speed and coefficient of steadiness.	BT1	Remember
14.	Discuss the various types of stresses induced in a flywheel rim.	BT2	Understand
15.	Describe why flywheels are used in punching machines?	BT1	Remember
16.	Define the term fluctuation of energy.	BT1	Remember
17.	Explain why I-section is chosen for the connecting rod?	BT2	Understand
18.	Explain what are the stresses set up in an IC engine connecting rod?	BT2	Understand
19.	At what angle of the crank, the twisting moment is maximum in the crankshaft	BT2	Understand
20.	List out the various methods and materials used in the manufacture of crankshafts.	BT1	Remember
21.	State the construction of flywheels.	BT2	Understand
22.	What is helical torsion spring?	BT1	Remember
23.	What type of stress is induced in helical torsion spring?	BT1	Remember

24.	What are the applications of multi-leaf spring?	BT1	Remember
25	What are the applications of concentric spring?	BT1	Remember

	PART - B (13 Marks)			
S.No	**QUESTIONS**	**Marks**	**LEVEL**	**COMPETENCE**
1	Design a helical compression spring to sustain an axial load of 3KN. The deflection is 60mm. Spring index is 6. The shear stress is not to exceed 300 MPa. Rigidity modulus for spring material is 81 GPa.	13	BT3	Apply
2	A spring loaded safety value for a boiler is required to blow-off at a pressure 1.2 N/mm^2. The diameter of the value is 60 mm. Design a suitable compression spring for the safety value, assuming spring index to be 5, and 35 mm initial compression. The maximum lift of the valve is 10 mm. The shear stress in the spring material is to be limited to 500 MPa. Take $G = 0.8 \times 10^5$ MPa.	13	BT6	Create
3	Design closed coiled helical spring subjected a tensile load of magnitude varying from 2250N to 2750 N and the axial deflection of spring for this range of load is 6 mm. Design the spring, taking the spring index as 5 and safe shear stress for material equal to 420 MPa. $G=84kN/mm^2$	13	BT6	Create
4	At the bottom of a mine shaft, a group of 10 identical close coiled helical springs are set in parallel to absorb. The shock caused by the falling of the cage in case of a failure. the loaded cage weighs 75KN, while the counter weight has a weight of 15KN. If the loaded cage falls through a height f 50 meters from rest, find the maximum stress induced in each spring if it is made of 50mm diameter steel rod. The spring index is 6 and the number of active turn in each spring is 20. Modulus of rigidity G= $80KN.mm^2$.	13	BT3	Apply
5	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	13	BT6	Create

	Maximum inside diameter of spring = 25mm Length of the spring when the valve is open = 40mm Length of the spring when the valve is closed = 50mm Maximum permissible shear stress = 400 MPa			
6	A concentric spring for an aircraft engine valve is to exert a maximum force of 5000N under an axial deflection of 40mm.Both the springs have same free length, same solid length and are subjected to equal maximum shear stress of 850 MPa. If the spring index for both the spring is 6,find (a) the load shared by each spring,(b) the main dimensions of both the springs and (c) the number of active coils in each spring. G=80kN/mm^{2}and diametric clearance to be equal to the difference between the wire diameter.	13	BT6	Create
7	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.	13	BT6	Create
8	A semi-elliptical laminated vehicle spring to carry a load of 6000N is to consist of seven leaves 65mm wide, two of the leaves extending the full length of the spring. The spring is to be 1.1m in length and attached to the axle by two U-bolts 80mm apart. The bolts hold the central portion of the spring so rigidly that they may be considered equivalent to a band having a width equal to the distance between the bolts. Assume the design stress for spring material as 350 MPa. Determine thickness of the leaves, deflection of spring, diameter of eye, length of leaves and radius to which leaves should initially bent.	13	BT6	Create
9	A 5kW induction motor, running at 960 rpm operates a riveting machine. The flywheel fitted to it, is of mass 120 kg, with radius of gyration equal to 0.35 m. Each riveting takes 1 second and requires 9 kW. Determine (i) the number of rivets formed per hour and (ii)	13	BT3	Apply

	the reduction in speed of the flywheel, after the riveting operation.			
10	A single cylinder, single acting, four stroke oil engine develops 20kW at 300 rpm. The work done by the gases during the expansion stroke is 2.3 times the work done on the gases during the compression and the work done during the suction and exhaust strokes is negligible. The speed is to be maintained within ±1%.Determine the mass moment of inertia for the flywheel.	13	BT5	Evaluate
11	The turning moment diagram for a petrol engine is drawn to the following scales. Turning moment,1mm=5N.m,Cranking angle 1mm=1º.The turning moment diagram repeats itself at every half revolution of the engine and the areas above and below the mean turning moment line, taken in order are 295,685,40,340,960,270mm^2 .Determine the mass of 300 mm diameter flywheel rim when the co-efficient of fluctuation of speed is 0.3% and the engine runs at 1800 rpm. Also determine the cross section of the rim when the width of the rim is twice of thickness. Assume density of rim material as 7250kg/m^3.	13	BT3	Apply
12	Design a plain carbon steel centre crankshaft for a single acting four stroke single cylinder engine for the following data. Bore = 400mm; Stroke = 600 mm; Engine speed = 200 rpm; Mean effective pressure = 0.5 N/mm^2; Maximum combustion pressure = 2.5 N/mm^2; Weight of flywheel used as a pulley = 50 KN; Total belt pull = 6.5 kN. When the crank has turned through 35˚ from the top dead center, the pressure on the piston is 1N/mm^2 and the torque on the crank is maximum. The ratio of the connecting rod length to the crank radius is 5. Assume any other data required for the design.	13	BT3	Apply
13	Design a side or overhung crank shaft for a 250mmX300mm gas engine. The weight of the flywheel is 30kN and the explosion pressure is 2.1N/mm^2 .The gas pressure at the maximum torque is 0.9N/mm^2, when the crank angle is 35º from IDC. The connecting rod is 4.5 times the crank radius.	13	BT6	Create
14	Design a connecting rod for an IC engine running at 1800 rpm and	13	BT6	Create

	developing a maximum pressure of of 3.15 N/mm^2.The diameter of the piston is 100mm,mass of the reciprocating parts per cylinder 2.25kg,length of connecting rod 380mm,stroke of piston190mm and compression ratio 6:1.Take a factor of safety as 6 for the design. Take length to diameter ratio for big end bearing as 1.3 and small end bearing as 2 and the corresponding bearing pressures as $10N/mm^2$ and 15 N/mm^2.The density of material of the rod may be taken as $8000kg/m^3$ and the allowable stress in the bolts as $60N/mm^2$ and in cap as $80N/mm^2$.The rod is to be of I section for which you can choose your own proportions. Use Rankine formula for which the numerator constant may be taken as 320 N/mm^2 and the denominator constant 1/7500.			
15	A vertical spring loaded valve is required for a compressed air receiver. The valve is to start opening at a pressure of 1 N/mm^2 gauge and must be fully open with a lift of 4 mm at a pressure of 1.2 N/mm^2 gauge. The diameter of the port is 25 mm. Assume the allowable shear stress in steel as 480 MPa and shear modulus as 80 kN/mm^2. Design a suitable close coiled round section helical spring having squared ground ends. Also specify initial compression and free length of the spring.	13		
16	A railway wagon weighing 50 kN and moving with a speed of 8 km per hour has to be stopped by four buffer springs in which the maximum compression allowed is 220 mm. Find the number of turns in each spring of mean diameter 150 mm. The diameter of spring wire is 25 mm. Take G = 84 kN/mm^2.	13		
17	A helical compression spring made of oil tempered carbon steel, is subjected to a load which varies from 600 N to 1600 N. The spring index is 6 and the design factor of safety is 1.43. If the yield shear stress is 700 MPa and the endurance stress is 350 MPa, find the size of the spring wire and mean diameter of the spring coil.	13		
18	Design a concentric spring for an aircraft engine valve to exert a maximum force of 5000 N under a deflection of 40 mm. Both the	13		

	springs have same free length, solid length and are subjected to equal maximum shear stress of 850 MPa. The spring index for both the springs is 6.			
	PART-C (15 Marks)			
1	It is desired to design a valve spring of I.C. engine for the following details: a) Spring load when valve is closed = 80N b) Spring load when valve is open = 100 N c) Space constraints for the fitment of spring are: inside guide bush diameter = 24mm Outside recess diameter = 36mm d) Valve lift =5mm e) Spring steel has the following properties Maximum permissible shear stress = 350 MPa. Modulus of rigidity = 84kN/mm^2 Find: 1. Wire diameter 2. Spring index 3. Total number of coils 4. Solid length of springs 5. Free length of spring 6. Pitch of the coil when additional 15 percent of the working deflection is used to avoid complete closing of coils.	15	BT5	Evaluate
2	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.	15	BT5	Evaluate
3	A punching press pierces 35 holes per minute in a plate using 10kN-m of energy per hole during each revolution. Each piercing takes 40 per cent of the time needed to make one revolution. The punch receives power through a gear reduction unit which in turn is fed by a motor driven belt pulley 800 mm diameter and turning at 210 rpm. Find the power of the electric motor if overall efficiency of the transmission unit is 80 per cent. Design a cast iron flywheel to be used with the punching machine for a coefficient of steadiness of 5, if the space considerations limit the maximum diameter to 1.3 m. Allowable shear stress in the shaft material = 50MPa; Allowable	15	BT6	Create

	tensile stress of cast iron = 4 MPa. Density of cast iron = 7200 kg/m^3			
4	Determine 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	15	BT6	Create
5	A semi-elliptical spring has ten leaves in all, with the two full length leaves extending 625 mm. It is 62.5 mm wide and 6.25 mm thick. Design a helical spring with mean diameter of coil 100 mm which will have approximately the same induced stress and deflection for any load. The Young's modulus for the material of the semi-elliptical spring may be taken as 200 kN/mm^2 and modulus of rigidity for the material of helical spring is 80 kN/mm^2.	15	BT5	Evaluate

UNIT V - BEARINGS

Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi and Boyd graphs, -- Selection of Rolling Contact bearings.

PART - A (2Marks)

S.No	QUESTIONS	LEVEL	COMPETENCE
1.	Give two application where the inner race is rotating and out race is stationary in rolling contact bearings.	BT2	Understand
2.	Give an example for anti-friction bearing.	BT2	Understand
3.	List the advantages of hydrostatic bearings.	BT2	Understand
4.	List any two advantages of rolling contact bearings.	BT1	Remember
5.	In hydrodynamic bearing, what are factors which influence the formation fluid film?	BT2	Understand
6.	Define static capacity of bearing.	BT1	Remember
7.	What is full journal bearing? Give a classification of these bearings.	BT2	Understand
8.	Explain hydrodynamic lubrication.	BT2	Understand
9.	List the important physical characteristics of a good bearing material.	BT1	Remember
10.	Define bearing characteristic number.	BT1	Remember
11.	List out the application of angular contact and self-aligning ball bearings.	BT1	Remember
12.	How do you express the life of a bearing? What is an average or median life?	BT2	Understand
13.	Describe basic static load rating	BT1	Remember
14.	Describe bearing characteristic number.	BT2	Understand
15.	Write down the formula to calculate the heat generated and heat diss journal bearing.	BT1	Remember
16.	Define critical pressure.	BT1	Remember
17.	Write down the formula to calculate sommerfield number.	BT1	Remember
18.	State the theory of lubrication.	BT1	Remember
19.	What do you understand by non-metallic bearings?	BT2	Understand
20.	Explain partial journal bearing.	BT1	Remember
21.	What is wedge film and squeeze film journal bearing?	BT1	Remember
22.	Enumerate the factors that influence most the formation and maintenance of the hydrodynamic bearing.	BT1	Remember
23.	List the important physical characteristics of good beating material.	BT1	Remember
24.	What is meant by hydrodynamics lubrication?	BT2	Understand
25.	Write short note on classifications and different types of antifriction bearings.	BT2	Understand

	PART - B (13 Marks)			
S.No	**QUESTIONS**	**Marks**	**LEVEL**	**COMPETENCE**
1	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.	13	BT3	Apply
2	The load on the journal bearing is 150kN due to turbine shaft of 300mm diameter running at 1800 rpm. Determine the following. Length of the bearing if the allowable bearing pressure is 1.6N/mm^2 and amount of heat to be removed by the lubricant per minute if the bearing temperature is 60ºC and viscosity of the oil at 60ºC is 0.02 kg/m.s and the bearing clearance is 0.25 mm.	13	BT3	Apply
3	Design a journal bearing for a centrifugal pump from the following data: Load on the journal = 20000N; Speed of the journal = 900 rpm; Type of oil is SAE 10 for which the absolute viscosity at 55˚C = 0.017 kg/m-s; Ambient temperature of oil = 15.5˚C; Maximum bearing pressure for the pump = 1.5 N/mm2. Calculate also mass of the lubricating oil required for artificial cooling, if rise of temperature of oil be limited to 10˚C. Heat dissipation coefficient = 1232 W/m2/˚C	13	BT6	Create
4	A 100mm diameter full journal bearing supports a radial load of 5000N. The bearings is 100 mm long and operates at 400 rpm. Permissible min film thickness 25 micron. Diametral clearance 152 micron using Raimond & Boyd curves find (i) viscosity of suitable oil (ii) μ (iii) heat generation rate (iv) amount of oil pumped through bearing (v) amount of end leakage (vi) rise in temperature	13	BT3	Apply
5	(i).A footstep bearing supports a shaft of 150mm diameter which is	13	BT3	Apply

	counter bored at the end with a hole diameter of 50mm.If the bearing pressure is limited to 0.8N/mm^2 and the speed is 100 rpm, find the load to be supported, the power lost in friction and the heat generated at the bearing. (ii).The thrust of propeller shaft in a marine engine is taken up by a number of collars integral with the shaft which is 300mm is diameter. The thrust on the shaft is 200kN and the speed is 75 rpm. Taking μ constant and equal to 0.05 and assuming bearing pressure as uniform and equal to 0.3 N/mm^2,find number of collars required, power lost in friction and heat generated at the bearing in KJ/min.			
6	A shaft rotating at constant speed is subjected to variable load. The bearings supporting the shaft are subjected to stationary equivalent radial load of 3kN for 10% of time, 2kN for 20% of time, 1kN for 30% of time and no load for remaining cycle time. If the total life expected for the bearing is 20x10^6 revolutions at 95% reliability, calculate dynamic load rating of the ball bearing.	13	BT3	Apply
7	The rolling contact ball bearings are to be selected to support the overhung countershaft. The shaft speed is 720 rpm. The bearings are to have 99% reliability corresponding to a life of 24000 hours. The bearing is subjected to an equivalent radial load of 1kN.Consider life adjustment factors for operating condition and material as 0.9 and 0.85 respectively. Find the basic dynamic load rating of the bearing has 90% reliability.	13	BT5	Evaluate
8	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 10hours per day. Assume uniform and steady load.	13	BT3	Apply
9	The ball bearings are to be selected for an application in which the radial load is 2000N during 90 percent of the time and 8000N during the remaining 10 percent. the shaft is to rotate at 150 rpm. Determine the minimum value of the basic dynamic load rating for 5000 hours of operation with not more than 10 percent failures.	13	BT5	Evaluate

10	A ball bearing subjected to a radial load of 4000 N is expected to have a satisfactory life of 12 000 hours at 720 r.p.m. with a reliability of 95%. Calculate the dynamic load carrying capacity of the bearing, so that it can be selected from manufacturer's catalogue based on 90% reliability. If there are four such bearings each with a reliability of 95% in a system, what is the reliability of the complete system?	13	BT6	Create
11	A single row deep groove ball bearing operating at 2000 rpm is acted by a 10 kN radial load and 8kN thrust load. The bearing is subjected to a tight shock load and the outer ring is rotating. Determine the rating life of the bearing.	13	BT5	Evaluate
12	A wall bracket supports a Plummer block for 80mm diameter shaft. The length of the bearing is 120mm.The cap of bearing is fastened by means of four bolts, two n each side of the shaft. The cap is to withstand a load of 16.5kN.The distance between the centre lines of the bolts is 150mm.Determine the thickness of the bearing cap and the diameter of the bolts. Assume the stresses in tension for the material for the cap is cast iron as 15MPa and for bolts as 35MPa.Also check the deflection of the bearing cap taking $E=110kN/mm^2$.	13	BT6	Create
13	A roller bearing is be selected to withstand a radial load of 4000N and have an L10 life of 1200 hours at a speed of 600 rpm i. What is the basic dynamic load rating of the bearing to be selected? ii. If the reliability required is 99%, what load rating would be used? Take b=1.17 and V=S=1	13	BT5	Evaluate

<table>
<tr>
<td>14</td>
<td>Select a single row deep groove ball bearing with the operating cycle as below which will have a life of 15000hours.Assume radial and axial load factors to be 1 and 1.5 respectively and inner race rotates.
<table>
<tr><th>Fraction of cycle</th><th>Type of load</th><th>Radial, N</th><th>Thrust, N</th><th>Speed, RPM</th><th>Service factor</th></tr>
<tr><td>1/10</td><td>Heavy shocks</td><td>2000</td><td>1200</td><td>400</td><td>3</td></tr>
<tr><td>1/10</td><td>Light shocks</td><td>1500</td><td>1000</td><td>500</td><td>1.5</td></tr>
<tr><td>1/5</td><td>Moderate shocks</td><td>1000</td><td>1500</td><td>600</td><td>2</td></tr>
<tr><td>3/5</td><td>No shocks</td><td>1200</td><td>2000</td><td>800</td><td>1</td></tr>
</table>
</td>
<td>13</td><td>BT5</td><td>Evaluate</td>
</tr>
<tr>
<td>15</td>
<td>The ball bearings are to be selected for an application in which the radial load is 2000 N during 90 per cent of the time and 8000 N during the remaining 10 per cent. The shaft is to rotate at 150 r.p.m. Determine the minimum value of the basic dynamic load rating for 5000 hours of operation with not more than 10 per cent failures.</td>
<td>13</td><td>BT5</td><td>Evaluate</td>
</tr>
<tr>
<td>16</td>
<td>A ball bearing subjected to a radial load of 5 kN is expected to have a life of 8000 hours at 1450 r.p.m. with a reliability of 99%. Calculate the dynamic load capacity of the bearing so that it can be selected from the manufacturer's catalogue based on a reliability of 90%.</td>
<td>13</td><td>BT5</td><td>Evaluate</td>
</tr>
<tr>
<td>17</td>
<td>A rolling contact bearing is subjected to the following work cycle :
(a) Radial load of 6000 N at 150 r.p.m. for 25% of the time; (b) Radial load of 7500 N at 600 r.p.m. for 20% of the time; and (c) Radial load of 2000 N at 300 r.p.m. for 55% of the time. The inner ring rotates and loads are steady. Select a bearing for an expected average life of 2500 hours.</td>
<td>13</td><td>BT5</td><td>Evaluate</td>
</tr>
<tr>
<td>18</td>
<td>The main bearing of a steam engine is 100 mm in diameter and 175 mm long. The bearing supports a load of 28 kN at 250 r.p.m. If the ratio of the diametral clearance to the diameter is 0.001 and the</td>
<td>13</td><td>BT5</td><td>Evaluate</td>
</tr>
</table>

<table>
<tr><td></td><td>absolute viscosity of the lubricating oil is 0.015 kg/m-s, find : 1. The coefficient of friction ; and 2. The heat generated at the bearing due to friction.</td><td></td><td></td><td></td></tr>
<tr><td></td><td><u>PART-C (15 Marks)</u></td><td></td><td></td><td></td></tr>
<tr><td>1</td><td>A ball bearing operates on the following work cycle:
<table><tr><th>Element No.</th><th>Radial Load (N)</th><th>Speed (RPM)</th><th>Element Time</th></tr><tr><td>1</td><td>3000</td><td>720</td><td>30</td></tr><tr><td>2</td><td>7000</td><td>1440</td><td>40</td></tr><tr><td>3</td><td>5000</td><td>900</td><td>30</td></tr></table>The dynamic load capacity of the bearing is 16 600 N. Calculate 1. The average speed of rotation; 2. The equivalent radial load; and 3. The bearing life.</td><td>15</td><td>BT6</td><td>Create</td></tr>
<tr><td>2</td><td>A ball bearing subjected to a radial load of 5 kN is expected to have a life of 8000 hours at 1450 rpm with a reliability of 99%. Calculate the dynamic load capacity of the bearing so that it can be selected from the manufacturers catalogue based on a reliability of 90%.</td><td>15</td><td>BT6</td><td>Create</td></tr>
<tr><td>3</td><td>Select appropriate type of rolling contact bearing under the following condition of loading giving reasons for your choice:
a. Light radial load with high rotational speed.
b. Heavy axial and radial load with shock
c. Light load where radial space is very limited
d. Axial thrust only with medium speed.</td><td>15</td><td>BT5</td><td>Evaluate</td></tr>
<tr><td>4</td><td>A tentative design of a journal bearing results in a diameter of 75mm and a length of 125mm for supporting a load of 20 kN. The shaft runts at 1000 rpm. The bearing surface temperature is not to exceed 75˚C in a room temperature 35˚C. The oil used has an absolute viscosity of 0.01 kg/m-s at the operating temperature. Determine the</td><td>15</td><td>BT5</td><td>Evaluate</td></tr>
</table>

	amount of artificial cooling required in watts. Assume d/c=1000.			
5	A journal bearing is proposed for a steam engine. The load on the journal is 3 kN, diameter 50 mm, length 75 mm, speed 1600 r.p.m., diametral clearance 0.001 mm, ambient temperature 15.5°C. Oil SAE 10 is used and the film temperature is 60°C. Determine the heat generated and heat dissipated. Take absolute viscosity of SAE10 at 60°C = 0.014 kg/m-s	15	BT5	Evaluate