SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF AGRICULTURE ENGINEERING

QUESTION BANK

V SEMESTER

1909515 – DESIGN OF BASIC MACHINE ELEMENTS

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Prepared by

Mr. KARTHICK K, Assistant Professor (O.G)

DEPARTMENT OF AGRICULTURE ENGINEERING

1909515 – DESIGN OF BASIC MACHINE ELEMENTS

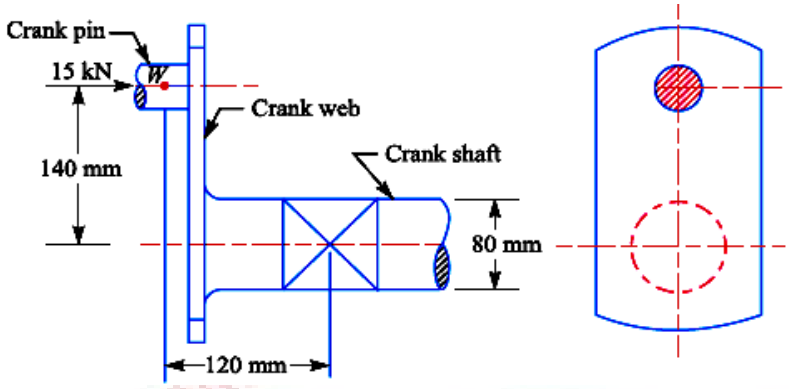
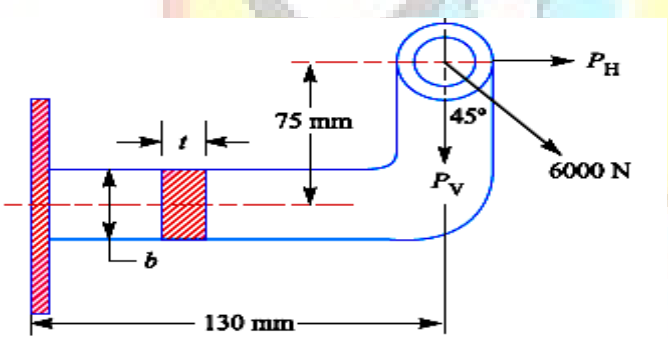
UNIT-I: STRESSES IN MACHINE MEMBERS
Introduction to design process- factor influencing the machine design, selection of material based on mechanical properties- Direct, bending and torsional stress equations- calculation of Principal stresses for combined loading. Design of curved beams- factor of safety – theories of failure-stress concentration- design of variable loading- Soderberg and Goodman relations.

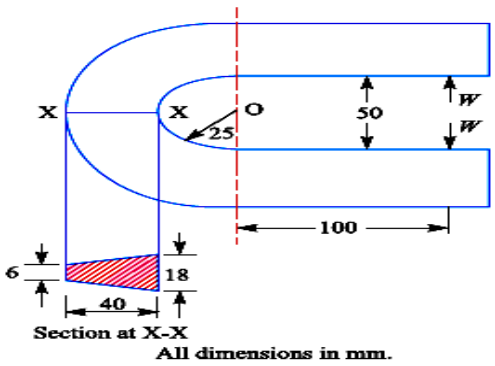
PART - A (2Marks)

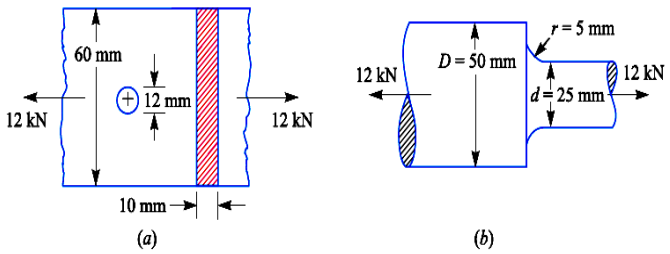
S.No	QUESTIONS	LEVEL	COMPETENCE
1.	Define notch sensitivity. State the relation between stress concentration factor, fatigue stress concentration factor and notch sensitivity.	BT1	Remember
2.	Define shock factor and what does it indicate	BT1	Remember
3.	Compare hardness and toughness.	BT2	Understand
4.	List out the various phases of design process.	BT1	Remember
5.	Define fits and tolerances. How are they designated?	BT1	Remember
6.	Describe your understanding by the nominal size and basic size.	BT2	Understand
7.	Define following terms a. Interchangeability b. Allowance	BT1	Remember
8.	Define “hole basic system” and “shaft basic system.	BT1	Remember
9.	Express your understanding by preferred numbers.	BT2	Understand
10.	List out the different types of loads that can act on machine components.	BT1	Remember
11.	Describe the common materials used in mechanical engineering design.	BT1	Remember
12.	Describe your understanding by factor of safety.	BT2	Understand
13.	List the important factors that influence the magnitude of factor of safety.	BT1	Remember
14.	Describe working stress and how it is calculated from the ultimate stress or yield stress of a material.	BT2	Understand
15.	Define endurance limit.	BT1	Remember

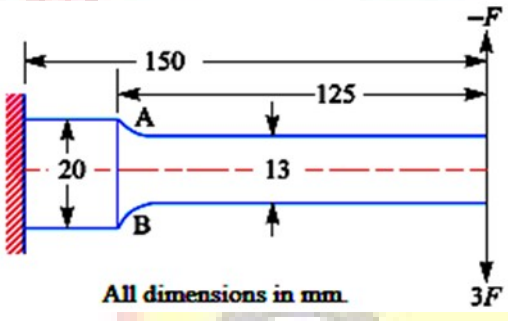
16.	Summarize theory of failure as suitable for the design of brittle materials.	BT2	Understand
17.	Differentiate between repeated stress and reversed stress.	BT2	Understand
18.	Define stress concentration and stress concentration factor.	BT1	Remember
19.	Give some methods of reducing stress concentration.	BT2	Understand
20.	Describe about Soderberg and Goodman lines.	BT1	Remember
21.	What are all the factors influencing the machine design?	BT1	Remember
22.	Define the term Ductility and Brittleness.	BT1	Remember
23.	Explain about Factor of safety to design a machine element.	BT2	Understand
24.	Define the term Reliability and Durability.	BT1	Remember
25.	Define poisons ratio.	BT1	Remember

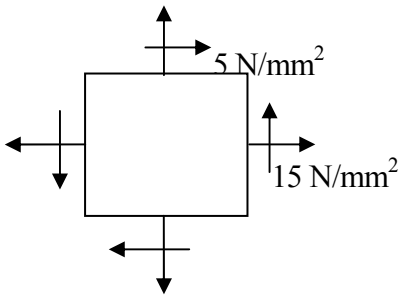
PART - B (13 Marks)			
S.No	**QUESTIONS**	**LEVEL**	**COMPETENCE**
1	A hypothetical machine member by 50mm in diameter and 250mm in diameter and 250mm long is supported in one end as cantilever is subjected to various types of loadings as given below. Calculate the principal stress and maximum shear 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	BT3	Apply
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.	BT3	Apply

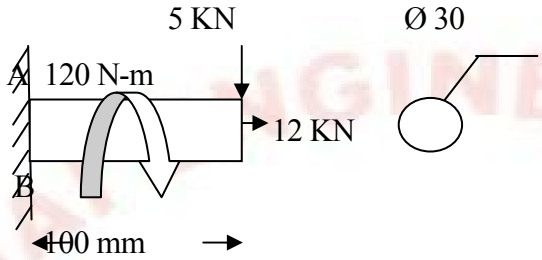
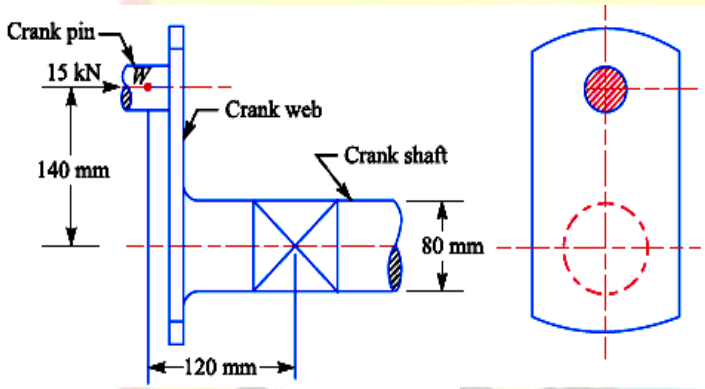
3	An overhang crank with pin and shaft is shown in Fig 1.1. A tangential load of 15kN acts on the crank pin. Determine the maximum principal stress and the maximum shear stress at the centre of the crankshaft bearing.  Fig 1.1	BT4	Analyze
4	A mild steel bracket as shown in Fig 1.2. is subjected to a pull of 6000N acting at 45° to its horizontal axis. The bracket has a rectangular section whose depth is twice the thickness. Calculate the cross-sectional dimensionsof the bracket, if the permissible stress in the materials of the bracket is limited to 60 MPa.  Fig 1.2	BT4	Analyze

5	(i) The frame of a punch press is shown in fig 1.3. Solve the stress at the inner and outer surface at section X-X of the frame, if W=5000N. (7)  Fig 1.3 (ii) What is factor of safety? List out the factors to be considered while deciding the factor of safety. (6)	BT3	Apply
6	The load on a bolt consists of an axial pull of 10kN together with a transverse shear force of 5kN. Calculate 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.	BT4	Analyze
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 maximumshear stress and 3. The maximum distortion strain energy theory of yielding.	BT3	Apply

8	Calculate the maximum stress induced in the following cases taking stress concentration into account: i. 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. (7) ii. A stepped shaft as shown in Fig 1.3. (b) and carrying a tensile load of 12 kN. (6)  Fig 1.3	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 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.	BT4	Analyze
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. Calculate the diameter of bar using safety factors of 3.5 related to ultimate tensile strength and 4 related to endurancelimit and a stress concentration factor of 1.65 for fatigue load. Use Goodman straight line as basis for design.	BT3	Apply
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	BT4	Analyze

	taking a factor of safety of 1.5, size effect of 0.85, surface finish of 0.9. The material properties of the bar are given by ultimate strength of 650 MPa, yield strength of 500 MPa and endurance strength of 350 MPa.		
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. Solve 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	BT3	Apply
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. Calculate 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.	BT3	Apply

14	A steel rod is subjected to a reversed axial load of 180KN. Solve 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	BT4	Analyze
15	A beam of 500 mm long fixed at one end is subjected to a bending load of 5KN at this free end. determine the area of cross section of the beam, if; (i) the cross section of the beam is circular. (ii) the cross section of the beam rectangular for which the depth of the section is twice that of the width. (iii) the cross section of the beam is **I-** section having flange thickness 't',depth '6t' and width '5t'. Also justify the economic section. Assume permissible stress of the beam material as 100 N/mm^2.	BT4	Analyze
16	A machine member is subjected to the stress as shown in fig. Determine the maximum principle stress, minimum principle stress, maximum shear stress and locate the angle of principle stress. 10 N/mm^2  	BT3	Apply

17	A circular shaft of 30mm diameter is subjected to an axial load,bending moment and twisting moment as shown in fig. Determine the maximum , minimum principle stress and maximum shear stress at the point A and B 	BT4	Analyze
18	A load of 15 KN is acting on the crank pin as shown in fig. the yield strength of the crank material is 400 N/mm^2 and its factor of safety is 2. Using maximum shear stress theory, find the diameter of the crank shaft section. 	BT3	Apply

	PART-C (15 Marks)		
1	(i) What theory is in better agreement for predicting the failure of ductile component? Sketch the schematic representation under bi-axial stresses for the theory. (5) (ii) What is mean by safety factor? (5) (iii) Design a wheel-chair in a multidisciplinary endeavor. (5)	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%. Calculate the diameter of shaft if a reduction factor of 1.2 is applied tothe variable component of bending stress and shearing stress. Assume i) that the maximum bending and shearing stresses are in phase ii) that the tensile yield point is the limiting stress for steady state component iii) that the maximum shear strength theory can be applied and iv) that the Goodman relation is valid, take following material properties: Yield strength = 500 MPa; Ultimate strength = 800 MPa; Endurance limit = ±400 MPa.	BT5	Evaluate
3	Design 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 FS =2	BT6	Create
4	Determine the diameter of a shaft to transmit twisting moment varying from 800N-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.	BT5	Evaluate
5	Explain in detail about the factors influencing the machine design.	BT6	Create

UNIT-II: DESIGN OF POWER TRANSMISSION SYSTEMS			
Selection of V-Belts and pulleys- selection of flat belts and pulleys- wire ropes and pulleys- selection of transmission chains and sprockets. Design of pulleys and sprockets.			
PART-A (2 Marks)			
Q.No	**QUESTIONS**	**BT Level**	**Competence**
1	Differentiate between open drive and cross drive of a belt drive.	BT-1	Remember
2	Describe how the ends of flat belt joined.	BT-1	Remember
3	Describe the term " Crowning of pulley."	BT-1	Remember
4	Express the ways, the timing belts are superior to ordinary V-belts.	BT-2	Understand
5	List the types of belt drives used for power transmissions.	BT-1	Remember
6	List the effect of centre distance and diameter of the pulley on the life of a belt.	BT-1	Remember
7	What is a Slack adjuster.	BT-2	Understand
8	Name the losses in belt drives.	BT-2	Understand
9	Define the centrifugal effects on belts.	BT-1	Remember
10	List the factors upon which the coefficient of friction between the belts and pulley depends.	BT-1	Remember
11	Define maximum tension in a belt. List the few materials for belt drives.	BT-1	Remember
12	Describe why slip is less in case of V-belts when compared to flat belts.	BT-2	Understand
13	Describe the cross section of V-belt and label its important parts.	BT-2	Understand
14	Describe how the wire ropes are designed. Write any four rope applications.	BT-1	Remember
15	Name the different types of compound wire ropes.	BT-1	Remember
16	Point out the circumstances chain drives are preferred over V belt drives.	BT-2	Understand
17	List the factors that affects the working conditions of chain drive.	BT-1	Remember
18	Name four elements in a chain. Give any three applications of chain drives.	BT-1	Remember

19	What is chordal action in chain drives?	BT-2	Understand
20	Define coefficient of friction. What do you mean by angle of friction?	BT-1	Remember
21	Define slip in belt and pulleys?	BT-1	Remember
22	Explain the advantages of belt drives?	BT-2	Understand
23	What are the factors should be considered during the selection of a belt drive?	BT-2	Understand
24	Explain the advantages of chain drives.	BT-2	Understand
25	Explain the different types of ropes.	BT-2	Understand
PART-B (13 Marks)			
Q.No	**QUESTIONS**	**BT Level**	**Competence**
1	Calculate the power capacity of the leather belt of 9mm x 250mm is used to drive a CI pulley 900mm in diameter at 336rpm. If the active arc on the smaller pulley is 120^o and stress in tight side is 2Mpa. The density of the leather may be taken as 980 kg/m^3 and coefficient of friction of leather on CI is 0.35.	BT-3	Apply
2	A flat belt drive for a fan running at 360rpm which is driven by a 10 KW at1440 rpm motor. The belt drive is open type and the distance between the pulley Centres is 2000 mm. The diameter of adriven pulley is 1 m.	BT-4	Analyze
3	Calculate a flat belt drive to transmit 20kW at 720rpm. The centre distance is 3m and the speed ratio is 3. Diameter of rolling pulley is 1.2 m.	BT-3	Apply
4	Design a flat belt drive to transmit 15 KW at 480 rpm from an engine to line shaft at 1200 rpm. The Centre distance between the pulleys is2m .The diameter of engine pulley is 600 mm.	BT-4	Analyze
5	A flat belt drive is required to transmit 12 KW from a motor runningat 720 rpm. The belt is 12 mm thick and has mass density of 0.001 gm/mm3. Permissible stress in the belt not to exceed 2.5 N/mm^2. Diameter of driving pulley is 250 mm whereas thespeed of driven pulley is 240 rpm. The two shafts are 1.25 m apart, coefficient of friction is 0.25. Calculate the width of the belt.	BT-3	Apply

6	Design a suitable V-belt for a centrifugal pump running at 340 rpm is to be driven by 100 KW motor at 1440 rpm. The drive is to workat least 20 hours every day. Centre distance is 1.2 m.	BT-4	Analyze
7	Calculate a V-belt drive to transmit 10kW at 400 rpm. The speed ratiois 3. Centre distance between the pulleys is 600 mm and the drive is crusher.	BT-3	Apply
8	Design a V-belt drive and calculate the actual belt tension and average stress for the following data. Driven pulley diameter = 500 mm, driver pulley diameter, d=150 mm, center distance C=925 mm, speed N_1 = 1000 rpm, N_2 = 300 rpm and power, P = 7.5kW.	BT-4	Analyze
9	A truck equipped with 9.5 KW engine uses a roller chain of the final drive to the rear axle. The driving sprocket runs at 900 rpm and driven sprocket at 400 rpm with a center distance of approximately600 mm. Calculate a suitable the roller chain.	BT-3	Apply
10	A roller chain drive is used between a driver shaft running at 1440 rpm and a driven shaft running approximately at 720rpm. The power transmitted is 15KW. The drive is to be used for 2 shifts/day with 8hours/shift. The center distance is approximately 1000mm and the chain tension can be adjusted by moving the motor in the rails. Design the drive.	BT-4	Analyze
11	A workshop crank carries a load of 30KN using wire ropes and a hook. The hook weighs 15KN. Diameter of the rope drum is 30 timesthe diameter of the rope. The load is lifted with an acceleration of 1m/s^2. Calculate the diameter of the rope. FS = 6, Er =80KN/mm^2,σu = 180KN/mm^2, cross section of the rope = 0.4x (Dia. of the rope) 2.	BT-3	Apply
12	A compressor is to run by a motor pulley running at 1440 rpm, speed ratio 2.5. Choose a flat belt crossed drive. Centre distances betweenpulley is 3.6m take belt speed as 16m/s. Load factor is 1.3 take a 5 ply, flat belt. Power to be transmitted to be 12 KW. High speed load rating is 0.0118KW/Ply/mm width at V=5 m/s. Calculate the width and length of the belt.	BT-3	Apply

13	At the construction site, 1 ton of steel is to be lifted up to a height of 20m with the help of 2 wire ropes of 6x 19 size, nominal diameter 12mm and breaking load 78 KN. Calculate the factor of safety if the sheave diameter is 56 d and if wire rope is suddenly stopped in one second when travelling at a speed of 1.2 m/s. What is the factor of safety if bending load is neglected?	BT-3	Apply
14	A centrifugal pump running at 340rpmisto be driven by a 100kw motor running at 1440rpm. The drive is to work for at least 20 hours every day. The centre distance between the motor shaft and the pump shaft is 2000mm. Suggest a suitable multiple V-belt drive for this application. Also calculate the actual belt tensions and stress induced.	BT-3	Apply
15	A V belt having a lap of 180° has a cross section area 2.5cm^2 and groove angle is 45°. The density of the belt is 0.0015 kg/cm^3 and maximum stress is limited to 400×10^4 N/m^2.if μ=0.15. find the power that can be transmitted, if the wheel has the mean diameter of 300 mm and runs at 1000 rpm.	BT-4	Analyze
16	Two shafts whose centres are 1 m apart are connected by a V-belt drive. The driving pulley is supplied with 100 kW and has an effective diameter of 300 mm. It runs at 1000 r.p.m while the driven pulley runs at 375 r.p.m: The angle of groove on the pulleys is 40°. The permissible tension in 400 mm^2 cross-sectional area of belt is 2.1 MPa. The density of the belt is 1100 kg/m^3. Taking μ = 0.28, estimate the number of belts required. Also calculate the length required of each belt.	BT-3	Apply
17	Design a cast iron pulley to transmit 20 kW at 300 r.p.m: The diameter of the pulley is 500 mm and the angle of lap is 180° The pulley has four arms of elliptical cross-section with major axis twice the minor axis. The coefficient of friction between the belt and the pulley surface is 0.3. The allowable belt tension is not to exceed 250 N in 10mm width. The allowable shear stress for the shaft material may be taken as 50 N/mm^2.	BT-4	Analyze
18	Design a V-belt drive to the following specifications : Power to be transmitted = 7.5 kW Speed of driving wheel =1440 r.p.m; Speed of driven wheel = 400 r.p.m. Diameter of driving wheel = 300 mm Centre distance =1000 mm Service = 16hours / day	BT-4	Analyze

PART -C (15 Marks)			
1	A leather belt 9mm X 250 mm is use to drive a cast iron pulley 900 mm in diameter at 336 rpm. If the active are on the smaller pulley is120^{o} and stress in tight side is 2 MPa. Evaluate the power capacity of the belt. The density of the leather may be taken as 980 kg/m^{3} and coefficient of friction of leather on cast iron is 0.35.	BT-5	Evaluate
2	Design a chain drive to actuate a compressor from a 12 kW electric motor at 900 rpm, the compressor begin 250 rpm, Minimum centre distance should be 500 mm, the chain tension maybe adjusted by shifting the motor on rails. The compressor is to work 8 hour/day.	BT-6	Create
3	Design a flat belt drive to transmit 110 kW for a system consisting of two pulleys of diameters 0.9 m and 1.2 m respectively, for a centre distance of 3.6 m, belt speed of 20 m/s and coefficient of friction =0.3.There is a slip of 1.2% at each pulley and 5% friction loss at each shaft with 20% over load.	BT-6	Create
4	Evaluate a chain drive to actuate a compressor from 15 KW electric motor running at 1000 rpm, the compressor speed being 350 rpm. The minimum centre distance is 500 mm. The compressor operates15 hours per day. The chain tension may be adjusted by shifting the motor.	BT-5	Evaluate
5	Design a wire rope for an elevator in a building 60 metres high and for a total load of 20 kN. The speed of the elevator is 4 m/sec and the full speed is reached in 10 seconds.	BT-5	Evaluate

UNIT-III: DESIGN OF SHAFTS AND COUPLINGS

Design of solid and hollow shafts based on strength and rigidity- Design of keys, keyway sand splines- Design of rigid and flexible couplings. Design of bolts and nuts - knuckle and cotter joints.

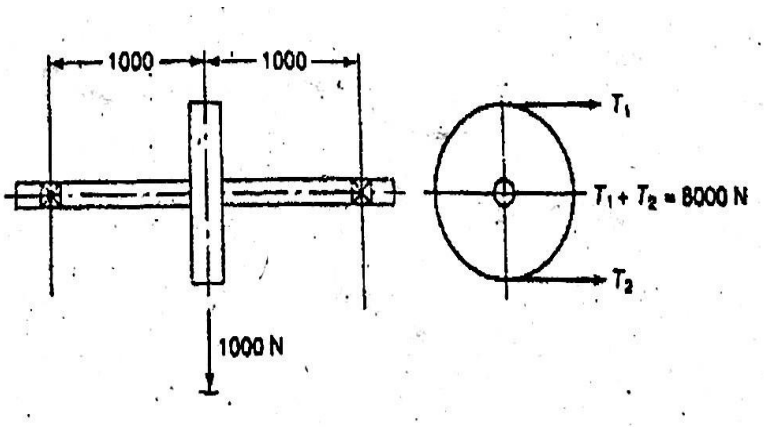
PART - A (2Marks)

S.No	QUESTIONS	LEVEL	COMPETENCE
1.	Distinguish 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 transmission shafts	BT2	Understand
4.	List out types of stresses induced in shafts.	BT1	Remember
5.	Point out, how the shaft is designed when it is subjected to twisting moment only.	BT2	Understand
6.	Define equivalent twisting moment and equivalent bending moment. State when these two terms are used in design of shafts.	BT1	Remember
7.	Describe when the shaft is subjected to fluctuating loads, what will be the equivalent twisting moment and equivalent bending moment.	BT2	Understand
8.	Define 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. Describe.	BT1	Remember
10.	Describe 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.	BT1	Remember
13.	Define how is the strength of a shaft affected by the keyway.	BT2	Understand
14.	Describe forces on keys.	BT1	Remember
15.	Differentiate between keys and splines.	BT2	Understand
16.	What are the considerations in the design of dimensions of formed and parallel key having rectangular cross-section.	BT2	Understand
17.	Define the possible modes of failure of the pin (bolt) in a flexible coupling.	BT2	Understand

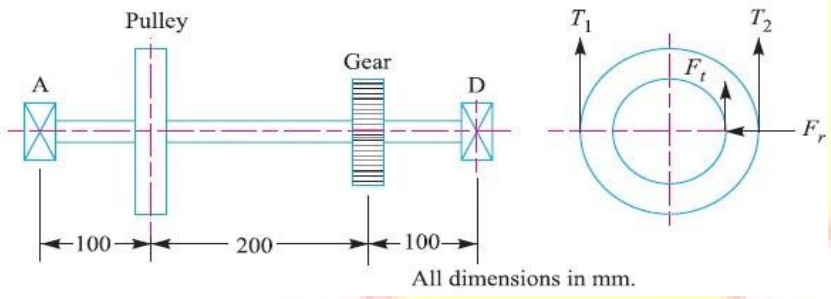
18.	Describe the function of a coupling. List at least three practical applications.	BT1	Remember
19.	Why are two universal joints often used when there is angular misalignment between two shafts.	BT1	Remember
20.	Describe under what circumstances flexible couplings are used.	BT2	Understand
21.	Define the function of key.	BT2	Understand
22.	Classify the types of coupling.	BT1	Remember
23.	Write the torsional equation for the hollow shaft.	BT1	Remember
24.	Sketch and specify the dimension of the square key.	BT1	Remember
25.	Define critical speed.	BT2	Understand

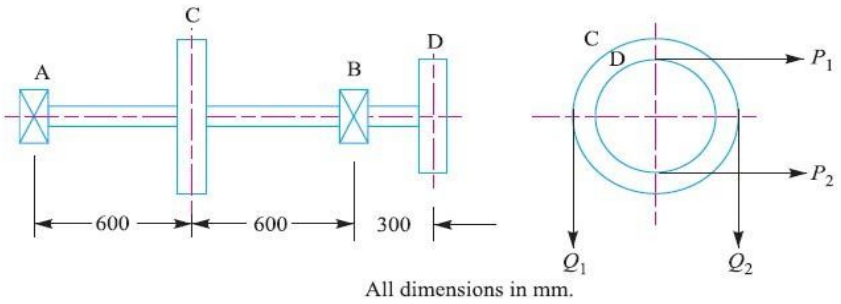
PART - B (13 Marks)			
S.No	**QUESTIONS**	**LEVEL**	**COMPETENCE**
1	A mild steel shaft transmits 20kW at 200 rpm. It carries a central load of 900N and is simply supported between the bearings 2.5m apart. Determine the size of the shaft, if the allowable shear stress is 42 MPa and the maximum tensile or compressive stress is not to exceed MPa. Calculate the size of the shaft will be required, if it is subjected to gradually applied loads.	BT3	Apply
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 $\mu = 0.24$. Calculate 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.	BT4	Analyze

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. Calculate the maximum bending moment and the necessary shaft diameter if the allowable shear stress of the material is 40 MPa.	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 of54MPa in shear, calculate the diameter of the shaft.	BT4	Analyze
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. Calculate (i). The maximum shear stress developed in the shaft (7) (ii). The angular twist between the bearings. (6)	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	BT3	Apply
7	Design a shaft to transmit power from an electric motor to a lathe 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.	BT4	Analyze
8	A shaft made of AISI 1030 cold drawn steel transmits 50 KW at 900 rpm through a gear. Calculate appropriate square key for the gear.	BT3	Apply
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.	BT4	Analyze

10	Calculate 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.	BT3	Apply
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.	BT4	Analyze
12	Calculate 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.	BT3	Apply
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.	BT4	Analyze
14	Calculate 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.	BT3	Apply
15	Two 35 mm shafts 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 r.p.m. 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 shear stress for 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	BT4	Analyze
16	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 all the parts are made of the same material having the following permissible stresses :	BT4	Analyze
17	Two 35 mm shafts 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 r.p.m. 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 shear stress for 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	BT3	Apply

18	The shaft and the flange of a marine engine are to be designed for flange coupling, in which the flange is forged on the end of the shaft. The following particulars are to be considered in the design : Power of the engine = 3 MW Speed of the engine = 100 r.p.m. Permissible shear stress in bolts and shaft = 60 MPa Number of bolts used = 8 Pitch circle diameter of bolts = 1.6 × Diameter of shaft Find : 1. diameter of shaft ; 2. diameter of bolts ; 3. thickness of flange ; and 4. diameter of flange.	BT3	Apply
	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 	BT6	Create
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. Evaluate 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.	BT5	Evaluate

	 Fig 2.3		
3	Two mild steel rods 40mm diameter are to be connected by cotter joint. The thickness of the cotter is 12mm. Evaluate the dimensions of the joint, if the maximum permissible stresses are 46 MPa; in tension 35MPa; in shear and 70 MPa in crushing.	BT5	Evaluate
4	Design a cotter joint to connect a piston rod to the cross-head. 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.	BT6	Create
5	Design a knuckle joint to transmit 200 kN. The design stresses may be taken as 90 MPa. in tension, 75 MPa in shear and 200 MPa in compression.	BT4	Analyze

UNIT-IV: DESIGN OF ENERGY STORING ELEMENTS			
Design of helical, leaf, disc and torsional springs under constant loads and varying loads - Concentric torsion springs.			
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.	BT1	Remember
2.	List out the various function of a spring. In which type of spring the behavior is non-linear.	BT1	Remember
3.	The extension springs are in considerably less use than the compression springs. Describe.	BT2	Understand
4.	Why, while designing helical springs, K is introduced in the shear stress equation?	BT1	Remember
5.	Define what do you understand stiffness of spring.	BT2	Understand
6.	Describe any one method of avoiding the tendency of a compression spring to buckle.	BT2	Understand
7.	Describe, what do you understand by full length and graduated leaves of a leaf-spring.	BT2	Understand
8.	Describe what is nipping in a leaf spring. Discuss its role.	BT2	Understand
9.	Define surge in a spring.	BT1	Remember
10.	Describe the utility of the centre bolt, U- clamp, rebound clip and camber in a leaf spring.	BT2	Understand
11	How the longest leaf is named in leaf springs?	BT1	Remember
12	Define stresses in compression springs for most of the materials with increase in size of wire will	BT1	Remember
13	Describe a shaft subjected to combined bending and torsion can be designed by following stress theory	BT2	Understand
14	Describe, what is the function of a spring. In which type of spring the behavior is non-linear.	BT2	Understand
15	Define the materials and practical applications for the various types of	BT1	Remember

	springs.		
16	Define the following terms of the spring : (i) Free length; (ii) Solid height;	BT1	Remember
17	Describe one method of avoiding the tendency of a compression spring to buckle.	BT2	Understand
18	Describe what is nipping in a leaf spring. Discuss its role.	BT1	Remember
19	Describe the application of Concentric helical springs.	BT1	Remember
20	Define, when two concentric coil springs made of the same material, having same length and compressed equally by an axial load, the load shared by the two springs will be to the square of the diameters of the wires of the two springs. (i) directly proportional (ii) inversely proportional	BT1	Remember
21	Classification of springs.	BT2	Understand
22	Sketch the disc spring.	BT1	Remember
23	How do you calculate the shear stress in the helical spring.	BT1	Remember
24	What is stiffness of the spring?	BT2	Understand
25	List out few spring materials.	BT1	Remember

PART - B (13 Marks)

S.No	QUESTIONS	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 exceed300 MPa. Rigidity modulus for spring material is 81 GPa.	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.	BT4	Analyze

3	Calculate a 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/$mm^{2.}$	BT3	Apply
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 of 50 meters from rest. Determine 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.	BT4	Analyze
5	Calculate 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 = 25mmLength of the spring when the valve is open = 40mmLength of the spring when the valve is closed = 50mm Maximum permissible shear stress = 400 MPa	BT3	Apply
6	Design 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 equalmaximum shear stress of 850 MPa. If the spring index for both the spring is 6, find (i) the load shared by each spring, (ii) the main dimensions of both the springs and (iii) 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.	BT4	Analyze

7	Calculate 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.	BT3	Apply
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.	BT4	Analyze
9	Calculate a leaf spring for the following specifications: Total load = 130 kN ; Number of springs supporting the load = 3; Maximum number of leaves = 9; Span of the spring = 900 mm; Permissible deflection = 70 mm. Take Young's modulus, E = 150 kN/mm^2 and allowable stress in spring material as 500 MPa.	BT3	Apply
10	Analyze a semi-elliptical laminated vehicle spring to carry a load of 5000N is to consist of seven leaves 60mm 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 70mm 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 300 MPa. Determine thickness of the leaves, deflection of spring, diameter of eye, length of leaves and radius to which leaves should initially bent.	BT4	Analyze
11	A concentric spring for an aircraft engine valve is to exert a maximum force of 4000 N under an axial deflection of 30 mm. Both the springs have same free length, same solid length and are subjected to equal maximum shear stress of 750 MPa. If the spring index for both the springs is 5, Calculate (i) the load shared by each spring, (ii) the main dimensions of both the springs, and (iii) the number of active coils in each spring. Assume G = 70 kN/mm2 and diametral clearance to be equal to the difference between the wire diameters.	BT3	Apply

12	A composite spring has two closed coil helical springs. The outer spring is 10 mm larger than the inner spring. The outer spring has 8 coils ofmean diameter 30 mm and wire diameter 5mm. The inner spring has 7 coilsof mean diameter 28 mm and wire diameter 3 mm. When the spring is subjected to an axial load of 300 N. Find 1. compression of each spring, 2. load shared by each spring, and 3. shear stress induced in each spring. The modulus of rigidity may be taken as 74 kN/mm2.	BT4	Analyze
13	A helical torsion spring of mean diameter 60 mm is made of a round wire of6 mm diameter. If a torque of 6 N-m is applied on the spring, find the bendingstress induced and the angular deflection of the spring in degrees. Calculatethe spring index is 10 and modulus of elasticity for the spring material is 200 kN/mm2. The number of effective turns may be taken as 5.5.	BT3	Apply
14	A helical torsion spring of mean diameter 50 mm is made of a roundwire of 6 mm diameter. If a torque of 5 N-m is applied on the spring, find the bending stress induced and the angular deflection of the spring in degrees. The spring index is 9 and modulus of elasticity for the spring material is 190 kN/mm2. The number of effective turns may be taken as 5.	BT4	Analyze
15	Design a close coiled helical compression spring for a service load ranging from 2250 N to 2750 N. The axial deflection of the spring for the load range is 6 mm. Assume a spring index of 5. The permissible shear stress intensity is 420 MPa and modulus of rigidity, G = 84 kN/mm2. Neglect the effect of stress concentration. Draw a fully dimensioned sketch of the spring, showing details of the finish of the end coils.	BT3	Apply
16	Find the maximum shear stress and deflection induced in a helical spring of the following specifications, if it has to absorb 1000 N-m of energy. Mean diameter of spring = 100 mm ; Diameter of steel wire, used for making the spring =20 mm; Number of coils = 30 ; Modulus of rigidity of steel = 85 kN/mm^2.	BT4	Analyze
17	A closely coiled helical spring is made of 10 mm diameter steel wire, the coil consisting of 10 complete turns with a mean diameter of 120 mm. The spring carries an axial pull of 200 N. Determine the shear stress induced in the spring neglecting the effect of stress concentration.Determine also the deflection in the spring, its stiffness and strain energy stored by it if the modulus of rigidity of the material is 80 kN/mm2.	BT3	Apply

18	A load vehicle is provided with 4 leaf springs each having a leaves and support are 1m apart and section of the leaves is 40×5 mm. the full capacity load for springs amount to 8000 m. the real axel taken 60percent of load, breaking strength 1200 N/mm^2.check the dimensions.	BT3	Apply
	PART-C (15 Marks)		
1	It is desired to design a valve spring of I.C. engine for the following details: i) Spring load when valve is closed = 80N ii) Spring load when valve is open = 100 N iii) Space constraints for the fitment of spring are: inside guide bush diameter = 24mm Outside recess diameter = 36mm iv) Valve lift =5mm v) Spring steel has the following properties Maximum permissible shear stress = 350 MPa. Modulus of rigidity = 84kN/mm^2 Evaluate: 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.	BT5	Evaluate
2	Design 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.	BT6	Create
3	A concentric spring for an aircraft engine valve is to exert a maximum force of 5000 N under an axial deflection of 40 mm. 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 springs is 6, Evaluate (i) the load shared by each spring, (ii) the main dimensions of both the springs, and (iii) the number of active coils in each spring. Assume G = 80 kN/mm2 and diametral clearance to be equal to the difference between the wire diameters.	BT5	Evaluate

4	Design a composite spring has two closed coil helical springs. The outer spring is 15 mm larger than the inner spring. The outer spring has 10 coils ofmean diameter 40 mm and wire diameter 5mm. The inner spring has 8 coilsof mean diameter 30 mm and wire diameter 4 mm. When the spring is subjected to an axial load of 400 N, find 1. compression of each spring, 2. load shared by each spring, and 3. shear stress induced in each spring. The modulus of rigidity may be taken as 84 kN/mm2.	BT6	Create
5	Design a leaf spring for the following specification for a truck. Maximum load on springs=120KN No of springs=4 Metals of springs=Cr Va Steel Span of spring=1200 mm Width of the central band= 200 mm Permissible deflection=120 mm	BT6	Create

UNIT-V: DESIGN OF GEARS AND BEARINGS

Gears - spur gear and helical gear - terminology - strength of gear teeth - Lewis equation - Buckingham equation. - Failure of gear teeth. - Applications of different types of Gears - Types of bearings – sliding contact and rolling contact types. – Bearing selection based on application - Lubrication in journal bearings – calculation of bearing dimensions.

PART - A (2Marks)

S.No	QUESTIONS	LEVEL	COMPETENCE
1.	Discuss law of gearing and summarize how interference can be avoided in gear.	BT2	Understand
2.	Name the profiles of spur gear. List the various methods of manufacturing gears.	BT2	Understand
3.	Describe the following (i) Pressure angle (ii) Diametrical pitch (iii) module	BT1	Remember
4.	List the different types of gear mechanism.	BT1	Remember
5.	Describe backlash. What factors influence backlash?	BT2	Understand
6.	Define undercutting in gears.	BT1	Remember
7.	Describe why is gear tooth subjected to dynamic load.	BT2	Understand
8.	Define the main types of gear tooth failure.	BT1	Remember
9.	Describe why dedendum value is more than addendum value.	BT1	Remember
10.	Name the materials commonly used for gears.	BT1	Remember
11.	List out the application of angular contact and self-aligning ball bearings.	BT1	Remember
12.	Describe 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.	What is bearing characteristic number?	BT2	Understand
15.	Write down the formula to calculate the heat generated and heat Dissipated in journal bearing.	BT1	Remember
16.	Define critical pressure.	BT1	Remember
17.	What is the formula to calculate sommerfield number?	BT2	Understand

18.	What is the theory of lubrication?	BT2	Understand
19.	What do you understand by non-metallic bearings?	BT2	Understand
20.	Define partial journal bearing.	BT2	Understand
21.	Write few bearing materials	BT1	Remember
22.	State the advantage of sliding contact bearing.	BT1	Remember
23.	Mention the features of bearing materials.	BT2	Understand
24.	What are the types of bearing.	BT1	Remember
25.	Define gear ratio.	BT2	Understand

PART - B (13 Marks)			
S.No	**QUESTIONS**	**LEVEL**	**COMPETENCE**
1	Design a pair of straight spur gear drive for a stone crusher, the gears are made of C40 steel. The pinion is to transmit 30 KW at 1200 rpm.The gear ratio is 3. The gear is to work 8 hours/day 6days in a week for 3 years.	BT3	Apply
2	Calculate a spur gear pair to transmit 22.5KW at 900 rpm. Speed reduction ratio is 2.5. Material for pinion and wheel are C15 steel and cast iron grade 30 respectively. Take pressure angle 200 and working life of gear is 10,000 hours.	BT4	Analyze
3	Design a spur gear drive required to transmit 45 KW at pinion speed of 800 rpm. The velocity ratio is 3.5:1. The teeth are 200 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 condition.	BT3	Apply
4	Design a straight spur gear drive to transmit 8KW. The pinion speed is 720rpm and the speed ratio is 2. Both the gears are made of the same surface hardened carbon steel with 55RC and core hardness less than 350BHN. Ultimate strength is 720N/mm^2 and yield strength is 360 N/mm^2.	BT4	Analyze
5	Calculate a spur gear to transmit 2 KW at 1440 rpm. Desired speed ratio is 3. Use C45 steel for gears.	BT3	Apply

6	A 37.5 kW power is transmitted at 450 rpm to a shaft running at approximately 112 rpm through a spur gear drive. The load is steady and continuous. Designthe gear drive and check the design. Illustrate the following materials: Pinion- heat treated cast steel; Gear-High grade cast iron.	BT3	Apply
7	Design a spur gear drive for a heavy machine tool with moderate shocks. The pinion is transmitting 18KW at 1200 rpm with a gear ratio of 3.5. Designthe drive and check for elastic stress and plastic deformation. Make a sketch and label important dimensions arrived.	BT4	Analyze
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. Solve and assume uniform and steady load.	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.	BT4	Analyze
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, Explain what is the reliability of the complete system.	BT3	Apply
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. Explain the rating life of the bearing.	BT4	Analyze

<table>
<tr><td>12</td><td>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.Solve 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.</td><td>BT3</td><td>Apply</td></tr>
<tr><td>13</td><td>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. Determine the basic dynamic load rating of the bearing to be selected. (7)
ii. If the reliability required is 99%, explain what load rating would be used. Take b=1.17 and V=S=1 (6)</td><td>BT4</td><td>Analyze</td></tr>
<tr><td>14</td><td>Design a single row deep groove ball bearing with the operating cycleas 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>BT3</td><td>Apply</td></tr>
<tr><td>15</td><td>Selected a suitable deep groove ball bearing for a drill machine spindle of 50 mm diameter. Thrust is 2KN spindle speed is 3000rpm.desired life is 3000 hrs.</td><td>BT4</td><td>Analyze</td></tr>
<tr><td>16</td><td>Design a helical gear to transmit 15 kW at 1440 rpm to the following specification. Speed reduction is 3, Pressure angle is 20 degree and helix angle is 15 degree. The material for both the gears is C45 steel. Allowable static stress is 180 N/mm2 , Surface endurance limitis 800 N/mm2 and Young’s Modulus of material is 2 x 10 5 N/mm</td><td>BT6</td><td>Creating</td></tr>
<tr><td>17</td><td>Design a helical gear for the following specification: Power- 12.5kW, Pinion speed-1200 rpm, Gear Ratio - 3.5, Pressure angle is 20 degree, helix angle is 15 degree. Gear is expected to work 6hours/day for 10 years</td><td>BT6</td><td>Creating</td></tr>
</table>

18	A helical gear with 30 º helix angle has to transmit 35kW at 1500 rpm with a speed reduction ratio 2.5. If the pinion has 24 teeth determine the necessary module, pitch diameter and face width for 20 degree full depth teeth. Assume 15Ni 2Cr 1 Mo15 material for both pinion and wheel	BT6	Creating
	PART-C (15 Marks)		
1	Design a pair of spur gear to transmit 20 KW at a pinion speed of 1440 rpm. The transmission ratio is 4.Assume 15Ni2Cr1Mo15 for pinion and C45 for gears.	BT6	Create
2	For intermittent duty of an elevator, two cylindrical gears made of alloys steel 40 Ni 2 Cr 1 Mo 28, and have to transmit12.5 kw at a pinion speed of 1200 rpm. Design a gear pair for the following specifications: Gear ratio: 3.5, pressure angle 200, involute full depth, helix angle 150. Gears are expected to work 6 hrs a day for 10 years. Minimum number of teeth on pinion can be taken as 20 and IS quality 8.	BT5	Evaluate
3	Select appropriate type of rolling contact bearing under the following condition of loading giving reasons for your choice: i. Light radial load with high rotational speed. ii. Heavy axial and radial load with shock iii. Light load where radial space is very limited iv. Axial thrust only with medium speed.	BT5	Evaluate
4	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. Design the amount of artificial cooling required in watts. Assume d/c=1000.	BT6	Create
5	Design a pair of helical gears to transmit 10 kW at 1000 rpm of the pinion and wheel are made of C15 steel and cast iron grade 30 respectively. The pinion is to transmit 22 kW power at 900 rpm. The gear ratio is 2.5, take pressure angle of 20º and helix angle is 15º. The material for the both gears is NI2Cr1Mo28.Give details of drive in tubular form	BT6	Create