INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad-500043

MECHANICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Title	**DESIGN OF MACHINE MEMBERS**				
Course Code	**AME012**				
Programme	B.Tech				
Semester	V	ME			
Course Type	Core				
Regulation	**IARE - R16**				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Dr. G V R Seshagiri Rao, Associate Professor				
Course Faculty	Mr. V K V S Krishnam Raju, Associate Professor				

COURSE OBJECTIVES:

The course should enable the students to:	
I	Develop an ability to apply knowledge of mathematics, science, and engineering Outcomes
II	Knowledge of various design standards, safety, reliability, importance of dimensional parameters and manufacturing aspects in mechanical design.
III	Understanding the concepts of stresses, theories of failure and material science to analyze, design and/or select commonly used machine components.
IV	To develop an ability to identify, formulate, and solve various machine members problems

COURSE OUTCOMES (COs):

CO1	Understanding design and analysis of power transmitting elements, selection of suitable materials and manufacturing processes.
CO2	Analyzing the forces acting on various joints and their design.
CO3	To develop an ability to identify, formulate, and solve various machine members problems
CO4	Ability to design and analyze shafts with different geometrical features under various loading conditions.
CO5	Ability to analyze and design of different Springs for required application.

COURSE LEARNING OUTCOMES:

AME012.01	Understand various design variables and factors in the study of machine elements.
AME012.02	Explain the steps involved in design process, BIS Codes of Steels.
AME012.03	Understand the various Theories of failure, Design for Strength and rigidity.
AME012.04	Understand theories of failures, stress concentration and fluctuating stresses.
AME012.05	Explain estimation of endurance strength.
AME012.06	Ability to design lap and butt joints in riveted joints.
AME012.07	Explain design of welded joints, effects various stresses.
AME012.08	Explain the design procedure of various joints.
AME012.09	Understand the applications and comparison of various joints.
AME012.10	Explain bolts of uniform strength.
AME012.11	Understand various stresses in keys.
AME012.12	Ability to design procedure for keys.
AME012.13	Ability to design spigot and socket joint.
AME012.14	Understand Jib and Cotter joint and design procedure.
AME012.15	Ability to design knuckle joints.
AME012.16	Explain the design of shafts for complex loads.
AME012.17	Explain the design procedures of various shaft couplings.
AME012.18	Ability to design shafts for various types of loading.
AME012.19	Compare various shaft couplings and applications.
AME012.20	Ability to Design of various shaft couplings.
AME012.21	Understand of the basic features of springs.
AME012.22	Explain the design procedure for various springs.
AME012.23	Ability to design the various springs.
AME012.24	Compare applications of Extension springs.
AME012.25	Explain different types of end styles for helical compression and tension springs.

TUTORIAL QUESTION BANK

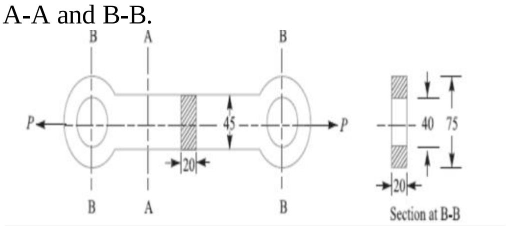
UNIT-I

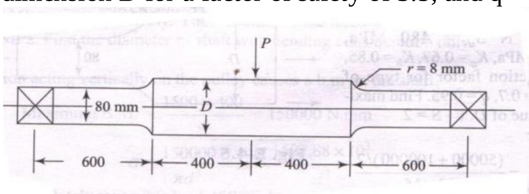
FUNDAMENTALS OF MACHINE DESIGN

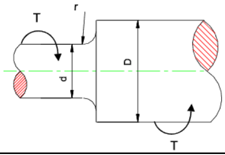
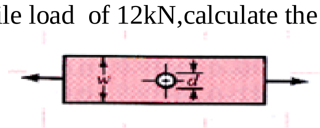
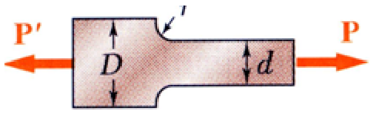
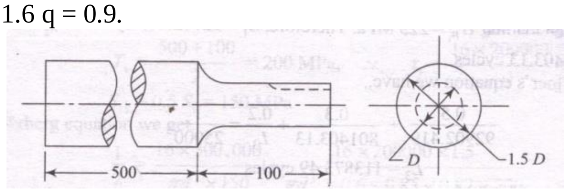
PART - A (SHORT ANSWER QUESTIONS)

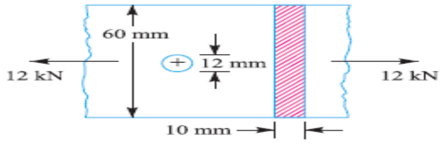
S No	Question	Blooms Taxonomy level	Course Outcomes (COs)	Course Learning Outcomes (CLOs)
1	List out various factors to be considered while designing a component	Remember	CO 1	AME012.01
2	Illustrate the properties of non-metals	Understand	CO 1	AME012.01
3	State the applications of non-metals in design	Understand	CO 1	AME012.01
4	Write the difference between ductile and brittle	Understand	CO 1	AME012.01
5	Define stiffness for axial loaded member	Understand	CO 1	AME012.02
6	Write about factor of safety under static loading and fluctuating loads	Remember	CO 1	AME012.02
7	Write short notes on design procedure based on strength and rigidity	Remember	CO 1	AME012.02
8	Define fatigue	Remember	CO 1	AME012.02
9	Define fatigue stress concentration factor	Remember	CO 1	AME012.03
10	Define is stress concentration?	Remember	CO 1	AME012.03
11	Define is Theoretical stress concentration factor	Understand	CO 1	AME012.03
12	What is notch sensitivity?	Remember	CO 1	AME012.03
13	Define factor of safety for fatigue loading	Remember	CO 1	AME012.04
14	Define completely reversed loading	Remember	CO 1	AME012.04
15	Define alternating loading	Remember	CO 1	AME012.04
16	Define repeated loading	Understand	CO 1	AME012.04
17	Write equation for mean average stress	Understand	CO 1	AME012.05
18	Write equation for variable stress	Understand	CO 1	AME012.05
19	Define stress ratio	Remember	CO 1	AME012.05
20	Explain manufacturing consideration in design	Remember	CO 1	AME012.05

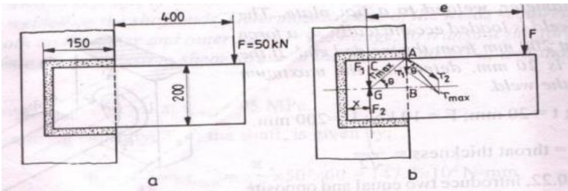
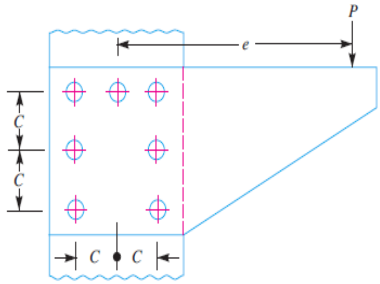
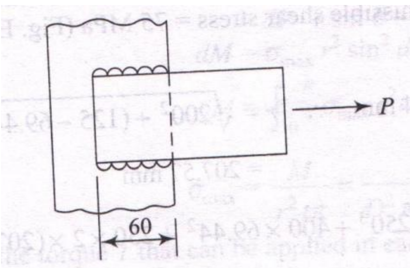
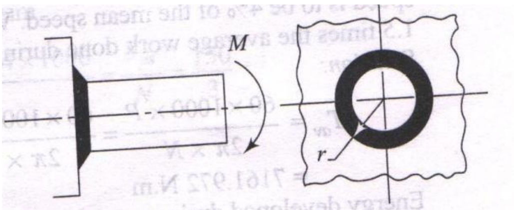
PART - B (Long Answer Questions)

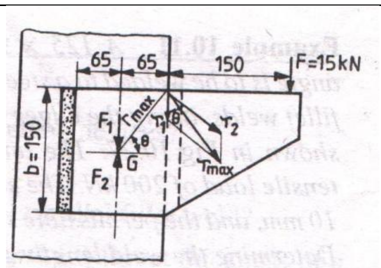
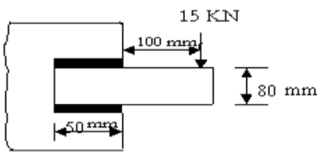
S No	Question	Blooms Taxonomy Level	Course Outcomes (COs)	Course Learning Outcomes (CLOs)
1	a. Define “Machine Design” and explain various stages with a flow chart. b. A cast iron link, as shown in Fig. is required to transmit a steady tensile load of 45 kN. Find the tensile stress induced in the link material at sections A-A and B-B. 	Understand	CO 1	AME012.01
2	a. What is factor of safety? Why is it necessary? List the important factors that influence the magnitude of factor of safety b. Shaft is transmitting 100 kW at 160 r.p.m. Find a suitable diameter for the shaft, if the maximum torque transmitted exceeds the mean by 25%. Take maximum allowable shear stress as 70 MP.	Understand	CO 1	AME012.01
3	a. Define simple stress and give few examples of machine components subjected to simple stress. b. Determine the diameter of a ductile steel bar subjected to an axial tensile load of 40kN and a torsional moment of 16 x 105N.mm.Use factor of safety of 1.5, E=2 x 105 MPa and Sy= 210MPa.	Understand	CO 1	AME012.02
4	a. Define failure. What are the possible modes offailure? b. A shaft is designed based on maximum energy of distortion as the criteria of failure and factor of safety of 2. The material used is 30C8 steel with Sy = 310 MPa. The shaft is subjected to an axial load of 40 kN. Determine the maximum torque that can be applied to theshaftbefore yielding. Diameter of shaft is 20 mm.	Understand	CO 1	AME012.02
5	A hollow shaft of 40 mm outer diameter and 25 mm inner diameter is	Understand	CO 1	AME012.03

	subjected to a twisting moment of 120 N-m, simultaneously; it is subjected to an axial thrust of 10 kN and a bending moment of 80 N-m. Calculate the maximum compressive and shear stresses. The load on a bolt consists of an axial pull of 10 kN together with a transverse shear force of 5 kN. Find the diameter of bolt required according to 1. Maximum principal stress theory 2. Maximum shear stress theory; 3. Maximum principal strain theory; 4. Maximum strain energy theory; and 5. Maximum distortion energy theory.			
6	a. A cylindrical shaft made of steel of yield strength 700 MPa is subjected to static loads consisting of bending moment 10 kN-m and a torsional moment 30 kN-m. Determine the diameter of the shaft using two different theories of failure, and assuming a factor of safety of 2. Take E = 210GPa and poisson's ratio = 0.25. b. Determine the diameter of a circular rod made of ductile material with a fatigue strength (complete stress reversal), σe = 265 MPa and a tensile yield strength of 350 MPa. The member is subjected to a varying axial load from Wmin = – 300 × 103 N to Wmax = 700 × 103 N and has a stress concentration factor = 1.8. Use factor of safety as 2.0.	Understand	CO 1	AME012.04
7	a. Explain which three theories of failure are applicable to ductile materials. b. Prove that for maximum shear stress theory Sys = 0.5 Sy for pure shear and Sys = 0.577 Sy for pure shear with energy of distortion theory.	Understand	CO 1	AME012.04
8	a. The non-rotating shaft shown in Fig. is subjected to a load P varying from 4000 N to 12000 N. The material 30C8 steel has Su = 600 MPa and Se= 300 MPa. Ka = 0.8, Kb = 0.85 and Kc = 0.9. b. Find the dimension D for a factor of safety of 3.5, and q = 0.9. 	Understand	CO 1	AME012.04
9	The endurance strength for a part is 280 MPa while Su = 630 MPa. It is subjected to a loading as follows σm1 = 315 MPa and σv1 = 96 MPa for 80% of time σm2 = 245 MPa and σv2 = 145 MPa for 20% of time Find the expected life in number of cycles of reversals. Assume Kt = 1.5.	Understand	CO 1	AME012.05
10	A shaft is subjected to a torque varying between 5000 N.m to 10000 N.m. The stress concentration factor due to the keyway is 2.5. Su = 500 MPa, Se =0.5 Su, Sy = 300 MPa, endurance correction factor = 0.6, size correction factor = 0.8 and surface correction factor = 0.82. Find the diameter of the shaft using F. S = 2	Understand	CO 1	AME012.05
11	A bolts is subjected to an axial force of 12,000N, with a transverse Shear force of 6,000N. find the diameter at the bolt required according to: i) Maximum Principal stress theory ii) Maximum Principal strain theory iii) Maximum shear stress theory iv) Maximum distortion energy theory Assume permissible tensile stress at elastic limit is 100 N/mm2 and 1 / m = 0.25	Understand	CO 1	AME012.05
12	A bolt is subjected to an axial force of 10KN with a transverse shear force of 5 KN.The permissible tensile stress at elastic limit is 100 MPa and the poison’s ratio is 0.3 for the bolt material. Determine the diameter of the bolt required according to i. Max. principal stress theory ii. Max. shear stress theory iii. Max. principal strain theory iv. Max. strain energy theory, and v. Max. Distortion energy theory.	Understand	CO 1	AME012.05
13	Explain the basic procedure for Mechanical Engineering Design. Discuss the preferred numbers	Understand	CO 1	AME012.04

14	a) Discuss the various types of stresses and strain. b) Draw the stress strain curve for ductile and brittle materials and differentiate the ductile and brittle failures	Understand	CO 1	AME012.04
15	Discuss the Stress concentration in manufacturing design. What are the different methods to reduce the stress concentration factor?	Understand	CO 1	AME012.05
16	A stepped shaft subjected to a twisting moment of 20 N-m . The yield strength of the shaft material is 400 Mpa Taking factor of safety of 2.5, r= 5mm,d=25mm,D= 50mm determine the diameter of the shaft. 	Understand	CO 1	AME012.05
17	a) A rectangular plate 50 mm x 10mm with a hole 12 mm dia mm diameter and subjected to a tensile load of 12kN,calculate the maximum stress.  b) State the significance of stress concentration factor while designing a machine element.	Understand	CO 1	AME012.05
18	a) What is the difference between the stress concentration factor and stress intensity factor? b) Explain the causes of stress concentration	Understand	CO 1	AME012.05
19	Determine the largest axial load P that can be safely supported by a flat steel bar consisting of two portions,both 10mm thick , and respectively 40 and 60 mm wide, connected by fillets of radius r = 8 mm . Assume an allowable normal stress of 165 Mpa 	Understand	CO 1	AME012.05
20	Determine the size of a piston rod subjected to a total load of having cyclic fluctuations from 150 KN in compression to 25 KN in tension. The endurance limit is 360 MPa and yield strength is 400 MPa. Take impact factor = 1.25, factor of safety = 1.5, surface finish factor = 0.88 and stress concentration factor = 2.25	Understand	CO 1	AME012.05
	PART - C (ANALYTICAL QUESTIONS)			
1	A torque varying from 25kN. M to 75 kN. M is applied at the end of the shaft. Fillet radius r= D/2; Factor of safety = 1.6, material is 40 MN 2512 with S =350 MPa. Se = 250 MPa, Ka = 0.85, Kb = 0.82, Kc = 0.6, SCF due tokeyway = 1.6 q = 0.9. 	Understand	CO 1	AME012.03
2	a. Define endurance test and endurance limit. b. A Shaft of diameter d is subjected to a torque varying between 100 N.m to 500 N.m . Kr due to keyway is 1.5. F.S = 2, Sy = 300 MPa, Se = MPa 200 Correctionfactorfortorsion=0.6.Surfacefinishfactor=0.85and size factor = 0.82. Find the value of d.	Understand	CO 1	AME012.03
3	a. What is stress concentration? How does it affect the fatiguestrength? b. What are the different methods to reduce stressconcentration?	Understand	CO 1	AME012.04
4	a. Draw and explain the S-Ndiagram. b. A uniform bar having a machined surface is subjected to an axial load varying from 400kN to 150 kN. The material of the bar has Su= 630 MPa. Kc = 0.7 and Kt = 1.42. Find the diameter d of the rod using F.S = 1.5.	Understand	CO 1	AME012.03
5	a. Differentiate between boiler and structuraljoints. b. Two plates of 16mm thick are joint by double riveted lap joint pitch of each of row of rivets is 90mm. rivets are 25mm in diameterpermissiblestresses are 140 MPa in tension. 80 MPa in shear & 160 MPa in crushing. Find efficiency of joint.	Understand	CO 1	AME012.05

6	Design a suitable diameter for a circular shaft required to transmit 90 kW at 180 r.p.m. The shear stress in the shaft is not to exceed 70 MPa and the maximum torque exceeds the mean by 40%. Also find the angle of twist in a length of 2 metres. Take C = 90 GPa.	Understand	CO 1	AME012.05
7	Find the maximum stress induced in the following cases: Taking stress concentration intoaccount: A rectangular plate 60 mm ×10 mm with a hole 12 diameter asshown in Fig. and subjectedto a tensile load of 12 kN. 	Understand	CO 1	AME012.05
8	A bar of circular cross-section is subjected to alternating tensile forces varying from a minimum of 200 kN to a maximum of 500 kN. It is to be manufactured of a material with an ultimate tensile strength of 900 MPa 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.	Understand	CO 1	AME012.03
9	50 mm diameter shaft is made from carbon steel having ultimate tensile strength of 630 MPa. It is subjected to a torque which fluctuates between 2000 N-m to – 800 N-m.Using Soderberg methods, calculate the factor of safety. Assume suitable values for any other data needed.	Understand	CO 1	AME012.03
10	A simply supported shaft between bearings carries a steady load of 10 kN at the center. 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.	Understand	CO 1	AME012.05
UNIT-II				
IGN OF FASTENERS AND WELDED JOINTS				
	PART – A (SHORT ANSWER QUESTIONS)			
S No	**Question**	**Blooms Taxonomy level**	**Course Outcomes (COs)**	**Course Learning Outcomes (CLOs**
1	Explain the term riveted joint	Remember	CO 2	AME012.06
2	Explain is caulking and why is it necessary	Remember	CO 2	AME012.06
3	Explain diagonal pitch in riveted joint	Understand	CO 2	AME012.06
4	Explain margin in riveted joint	Remember	CO 2	AME012.07
5	Explain pitch in riveted joint	Remember	CO 2	AME012.07
6	Explain back pitch in riveted joint	Remember	CO 2	AME012.07
7	Explain uniform strength of riveted joint	Remember	CO 2	AME012.07
8	Define term welding joint	Remember	CO 2	AME012.07
9	Difference between welding joint and riveted joint	Remember	CO 2	AME012.07
10	Explain the advantages of welded joint	Remember	CO 2	AME012.08
11	Explain the advantage of riveted joint	Remember	CO 2	AME012.08
12	Explain the disadvantage of welded joint	Remember	CO 2	AME012.08
13	Explain the disadvantage of riveted joint	Remember	CO 2	AME012.09
14	Write the methods to make bolts and screws	Remember	CO 2	AME012.10
15	Explain about gasket	Remember	CO 2	AME012.10
16	Classify the types of riveted joints	Remember	CO 2	AME012.10
17	Classify the types of rivets	Remember	CO 2	AME012.10
18	Explain about Fullering	Remember	CO 2	AME012.10
19	Define fillet welds	Remember	CO 2	AME012.10
20	Why connected rod bolts are tightened with initial tension greater that external load	Remember	CO 2	AME012.10
	Part - B (Long Answer Questions)			
1	Double riveted lap joint is made between 15 mm thick plates. The rivet diameterand pitch are 25 mm and 75 mm respectively. If the ultimate stresses are 400 MPa in tension,320MPa in shear and 640 MPa in crushing, find the	Understand	CO 2	AME012.06

	minimum force per pitch which will rupturethe joint.If the above joint is subjected to a load such that the factor of safety is 4, find out the actualstresses developed in the plates and the rivets.			
2	a. Sketch any three basic types of welded joints. b. Figure shows an eccentrically loaded welded joint. Determine the fillet weld size. Allowable shear stress in the weld is 80 MPa. 	Understand	CO 2	AME012.06
3	An eccentrically loaded lap riveted joint is to be designed for a steel bracket asshown in Fig. The bracket plate is 25 mm thick. All rivets are to be of the same size. Load on the bracket,P = 50 kN ; rivet spacing, C = 100 mm; load arm, e = 400 mm.Permissible shear stress is 65 MPa and crushing stress is 120 MPa. Determine the size of therivets to be used for the joint. 	Understand	CO 2	AME012.06
4	a. What are V threads used for fasteners? b. What are the different series of threads and theirapplications?	Understand	CO 2	AME012.07
5	a. Compare the welded joint with rivetedjoint? b. Find the size of the weld in Fig. if the permissible shear stress is 80 MPa and the load acting on the connection P=60kN. 	Understand	CO 2	AME012.07
6	A cast iron cylinder head is fastened to a cylinder of bore 500mm with 8 stud bolts. The maximum pressure inside the cylinder is 2 MPa. The stiffness of park kp=3kb. What should be the initial lightening load so that the joint is leak proof at maximum pressure?	Understand	CO 2	AME012.07
7	a. Derive the expression for the maximum stress induced in weld subjected to torsional loading. b. A cylindrical beam is attached to support by weld as shown in Fig. and is subjected to a bending moment M. Find the maximum stress induced in the weld. 	Understand	CO 2	AME012.07
8	Fig. shows a plate bracket welded to a steel column loaded eccentrically. assuming that the size of weld 6 x 6 mm, determine the maximum stress induced in the weld.	Understand	CO 2	AME012.07

				
9	a. Differentiate between a stud, a bolt and a nut. b. The cylinder head of a steam engine with 250mm bore is fastened by eight stud bolts made of 30C8 Steel. Maximum pressure inside the cylinder is 1 MPa. Determine the size of bolts and the approximate tightening stress and torque. Take 20% overload. Assume Sy=300 MPa for bolt material.	Understand	CO 2	AME012.07
10	a. What are the different types of the stresses induced in bolts? Explain the procedure of designing a bolt subjected to direct tensile load. b. A bracket is fitted to the channel with 4 bolts. The dimension a=b=150mm distance of load from the C.G of the bolt arrangement is 300mm. Find the diameter of the bolts.	Understand	CO 2	AME012.08
11	a) What is the difference between caulking and fullering? Explain with the help of neat Sketches. b) Explain the following terms in connection with riveted joints i. Pitch ii. Back pitch iii. Diagonal pitch iv. Margin	Understand	CO 2	AME012.08
12	A double riveted lap joint is made between 15mm thick plates. The rivet diameter and pitch are 25mm and 75mm respectively. If the ultimate stresses are 400 MPa in tension and 320 MPa in shear and 640 MPa in crushing, find the minimum force per inch, which will rupture the joint. If the above joint is subjected to a load such that the factor of safety is 4, find out the actual stresses developed in the plates and the rivets.	Understand	CO 2	AME012.08
13	Two plates 16 mm thick are joined by a double riveted lap joint. The pitch of each row of rivets is 90 mm. The rivets are 25 mm in diameter. The permissible stresses are 140MPa in tension, 80MPa in shear and 160MPa in crushing. Find the efficiency of the joint.	Understand	CO 2	AME012.09
14	A double riveted butt joint in which the pitch of the rivets in the outer rows is twice that in the inner rows, connects two 8 mm thick plates with two cover plates each 6 mm thick. The diameter of rivets is 12 mm. Determine the pitches of the rivets in the two rows if the working stresses do not exceed the following limits. Tensile stress in plates = 120 N/mm2, Shear stress in rivets = 80 N/mm2, Bearing stress in rivets and plates = 130 N/mm2, Make a fully dimensioned sketch of the joint by showing at least two views.	Understand	CO 2	AME012.10
15	A triple riveted lap joint with zig-zag riveting is to be designed to connect two plates of 6 mm thickness. Determine the diameter of rivets, pitch of rivets and distance between the rows of rivet. Indicate how the joint will fail. Assume: σt = 120 MPa; shear stress = 100 MPa and σc = 150 MPa.	Understand	CO 2	AME012.10
16	Two plates 18 mm thick are joined by a double riveted lap joint. The pitch of each row of rivets is 80 mm. The rivets are 24 mm in diameter. The permissible stresses are 160 MPa in tension, 75 MPa in shear and 150 MPa in crushing. Find the efficiency of the joint.	Understand	CO 2	AME012.10
17	A bracket carrying a load of 15 KN is to be welded as shown in Figure. Find the size of weld required if the allowable shear stress is not to exceed 80 MPa. 	Understand	CO 2	AME012.10
18	a. What are the advantages and disadvantages of welded joints over riveted joints. b. Name the types of riveted and welded joints.	Understand	CO 2	AME012.10

19	Two plates 16 mm thick are joined by a double riveted lap joint. The pitch of each row of rivets is 90 mm. The rivets are 25 mm in diameter. The permissible stresses are 140 MPa in tension, 80 MPa in shear and 160 MPa in crushing. Find the efficiency of the joint.	Understand	CO 2	AME012.10
20	Discuss on bolts of uniform strength giving examples of practical applications of such bolts.	Understand	CO 2	AME012.10
	PART - C (ANALYTICAL QUESTIONS)			
1	A bracket is fitted to a vertical channel with 5 bolts, three at the top arid two at the bottom with all the bolts equally spaced. The value of P=20 kN, e=200mm, l1=50mm and l2=250mm. Find the diameter of the bolt.	Understand	CO 2	AME012.06
2	a. What is meant by a bolt of uniform strength? b. A steam engine cylinder of 300mm effective diameter is subjected to a steam pressure of 1.5 N/mm2. The cylinder head is connected by means of 8 bolts having yield strength of 320 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 fatigue stress concentration factor of 1.4, and factor of safety of 2; determine the size of the bolts required.	Understand	CO 2	AME012.06
3	A double riveted butt joint, in which the pitch of the rivets in the outer rows is twice that in the inner rows, connects two 16 mm thick plates with two cover plates each 12 mm thick. The diameter of the rivets is 22 mm. Determine the pitches of the rivets in the two rows if the working stresses are not to exceed the following limits: Tensile stress in plates = 100 MPa, Shear stress in rivets = 75 MPa and bearing Stresses in rivets and plates = 150 MPa. Make a fully dimensioned sketch of the joint showing atleast two views.	Understand	CO 2	AME012.06
4	A 200 X 150 X 10 mm angle is joined to a frame by two parallel fillet welds along the edge of 200 mm length. If the angle is subjected to a static load of 200 KN, find the length of weld at the top and bottom. The allowable shear stress for static loading may be taken as 75 MPa.	Understand	CO 2	AME012.07
5	Discuss the significance of the initial tightening load and the applied load so far as bolts are concerned.	Understand	CO 2	AME012.07
6	Two plates of 10 mm thickness each are to be joined by means of a single riveted double strap butt joint. Determine the rivet diameter, rivet pitch, strap thickness and efficiency of thejoint. Take the working stresses in tension and shearing as 80 MPa and 60 MPa respectively.	Understand	CO 2	AME012.07
7	Double riveted lap joint is made between 15mm thick plates. Rivet diameter and pitch are 25mm and 75mm respectively. If UTS are 400 MPa in tention 320 MPa in shear & 630 MPa in crushing find minimum force for pitch which will replace the joint. If above joint is subjected to load such that factor of safety is 4 find out actual stresses developed in the plate and rivets.	Understand	CO 2	AME012.07
8	Differentiate between (i) lap joint and butt joint, and (ii) chain riveting and zig-zag riveting.	Understand	CO 2	AME012.07
9	Explain the procedure for designing a longitudinal and circumferential joint for a boiler.	Understand	CO 2	AME012.07
10	What is an eccentric riveted joint? Explain the method adopted for designing such a joint?	Understand	CO 2	AME012.07

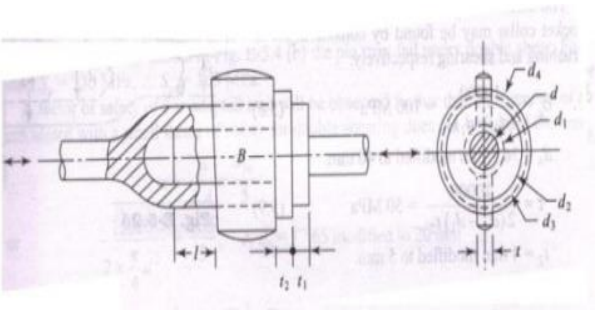
UNIT-III

DESIGN OF KEYS, COTTERS AND KNUCKLE JOINTS

PART – A (SHORT ANSWER QUESTION)

S No	Question	Blooms Taxonomy level	Course Outcomes (COs)	Course Learning Outcomes (CLOs)
1	Define what is a key where it is used	Remember	CO 3	AME012.11
2	Explain saddle key	Understand	CO 3	AME012.11
3	Explain sunk key	Understand	CO 3	AME012.11
4	Explain flat key	Understand	CO 3	AME012.12
5	Explain feather key	Understand	CO 3	AME012.12
6	Explain Kennedy key	Understand	CO 3	AME012.12
7	Explain the effect of key way on strength of shaft	Remember	CO 3	AME012.12
8	Explain types of stresses are introduced in a key	Remember	CO 3	AME012.12
9	Write the advantages of key	Understand	CO 3	AME012.13
10	Explain round key	Remember	CO 3	AME012.13

11	Write the applications of key	Understand	CO 3	AME012.13
12	What are the stresses induced in the knuckle joint.	Understand	CO 3	AME012.13
13	What is knuckle joint? And explain its applications.	Remember	CO 3	AME012.13
14	Explain about woodruff key	Understand	CO 3	AME012.14
15	What is cotter? Give its applications.	Remember	CO 3	AME012.14
16	Which material is generally used for cotter	Remember	CO 3	AME012.14
17	Why taper is given to the cotter	Remember	CO 3	AME012.14
18	Explain the purpose of Gib in cotter joint	Remember	CO 3	AME012.15
19	Write the applications of cotter joints	Remember	CO 3	AME012.15
20	Explain how slipping of cotter is avoided	Remember	CO 3	AME012.15
	Part - B (Long Answer Questions)			
1	a. Classify the keys and state their applications. b.A 45 mm diameter shaft is made of steel with yield strength of 400 MPa.A parallel key of size 14 mm wide and 9 mm thick made of steel with yield strength of 340 MPa is to be used. Find the required length of key, if the shaft is loaded to transmit the maximum permissible torque. Use maximum shear stress theory and assume a factor of safety of 2.	Understand	CO 3	AME012.11
2	a. Where and why the woodruff key is used? b.A 30 kW power is transmitted at 240 r.p.m, from 40 mm diameter shaft, by means of two Kennedy keys of 12 x 12 mm cross-section. Determine the length of the keys. For the keys, take permissible shear stress as 60 MPa, and Crushing stress as 90 MPa.	Understand	CO 3	AME012.11
3	A gear is mounted centrally on a shaft of 0.25m length, between the supports. The pitch circle diameter of the gear is 0.15m. The gear transmits 10kW power at 240 r.p.m. assuming suitable stresses for the materials, determine shaft diameter, Key dimensions and Minimum width of the gear.	Understand	CO 3	AME012.12
4	a) How are the keys classified? Draw neat sketches of different keys and their applications. b) A 15 KW, 960 r.p.m. motor has a mild steel shaft of 40mm diameter and the extension being 75 mm. The permissible shear and crushing stresses for the mild steel key are 56 MPa and 112 MPa. Design the keyway in the motor shaft extension. check the shear strength of the key against the normal strength of the shaft.	Understand	CO 3	AME012.13
5	a. Sketch the keys i) Wood ruff key ii) Kennedy key iii) Gib head key b. Determine the required length of a square key if the key and shaft are to be made of same material and of equal strength.	Understand	CO 3	AME012.13
6	Prove that a square key is equally strong in shear and compression	Understand	CO 3	AME012.13
7	Sketch any two sunk key diagrams and explain the design procedure.	Understand	CO 3	AME012.14
8	a. Name the modes of failure of a cotter in a cotter joint. b) Specify the different types of shafts giving their applications.	Remember	CO 3	AME012.14
9	a. Describe the design procedure of a gib and cotter joint. b. What are the applications of a cotter joint?	Understand	CO 3	AME012.14
10	Design a knuckle joint to transmit 140 kN, with permissible stresses in tension; shear and compression are 75 Mpa ; 60 Mpa and 150 Mpa respectively.	Understand	CO 3	AME012.14
11	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: σ =50 MPa; τ = 60 MPa and σ =90 MPa	Understand	CO 3	AME012.14
12	Design a knuckle joint to connect two mild steel bars under a tensile load of 25 kN. The allowable stresses are 65 MPa in tension, 50 MPa in shear and 83 MPa in crushing.	Understand	CO 3	AME012.14
13	A knuckle joint is required to withstand a tensile load of 25 kN. Design the joint if the permissible stresses are: σ =56 MPa; τ = 40 MPa and σ =70 MPa 1 c	Understand	CO 3	AME012.14
14	Design and draw a sleeve and cotter joint to connect two rods to transmit maximum tensile load of 75 kN. Assume sleeve cotter and rods are made of same material and design stresses in the material are 65 Mpa in tension; 130 MPa in crushing and 50 Mpa in shear.	Understand	CO 3	AME012.15
15	Design a knuckle joint to transmit 140 kN, with permissible stresses in tension; shear and compression are 75 Mpa ; 60 Mpa and 150 Mpa respectively.	Understand	CO 3	AME012.15
16	Design a cotter joint to connect two mild steel rods for a pull of 30 kN. The maximum permissible stresses are 55 MPa in tension; 40 MPa in shear and 70	Understand	CO 3	AME012.15

	MPa in crushing. Draw a neat sketch of the joint designed.			
17	Design a cotter joint to withstand an axial load varying from 50kN in tension to 50kN in compression. The allowable for the steel used in the joint are 60Mpa in tension; 75Mpa in crushing; 48Mpa in shear	Understand	CO 3	AME012.15
18	Design a cotter joint to withstand an axial load varying from 60 kN in tension to 60kN in compression. The allowable for the steel used in the joint are 60 Mpa in tension; 75 Mpa in crushing; 48 Mpa in shear.	Understand	CO 3	AME012.15
19	Design a knuckle joint to transmit 150 kN, with permissible stresses in tension; shear and compression are 75 Mpa; 60 Mpa and 150 Mpa respectively.	Understand	CO 3	AME012.15
20	Design a spigot and socket joint to connect two rods of 30 C8 steel to carry an axial tensile and compressive load of 10 kN. 	Understand	CO 3	AME012.15

PART - C (ANALYTICAL QUESTIONS)

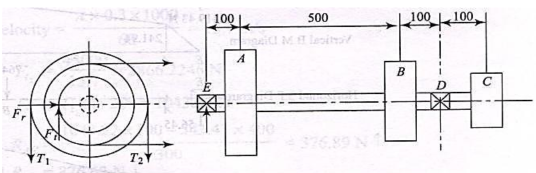
1	A shaft 80 mm diameter transmits power at maximum shear stress of 63 MPa. Find the length of a 20mm wide key required to mount a pulley on the shaft so that the stress in the key does not exceed 42MPa.	Understand	CO 3	AME012.13
2	A steel shaft has a diameter of 25 mm. The shaft rotates at a speed of 600 r.p.m. and transmits 30 kw through a gear. The tensile and yield strength of the material of shaft are 650 MPa and 353 MParespectively. Taking a factor of safety 3, select a suitable key for the gear. Assume that the key andshaft are made of the same material.	Understand	CO 3	AME012.13
3	Design a cotter joint to connect a piston rod to the crosshead. The maximum steam pressure on thepiston rod is 35 kN. Assuming that all the parts are made of the same material having the followingpermissible stresses: σ1 = 50 MPa ; τ = 60 MPa and σc = 90 MPa.	Understand	CO 3	AME012.14
4	Two rod ends of a pump are joined by means of a cotter and spigot and socket at the ends. Design the joint for an axial load of 100 kN which alternately changes from tensile to compressive. The allowable stresses for the material used are 50 MPa in tension, 40 MPa in shear and 100 MPa in crushing.	Understand	CO 3	AME012.14
5	Design and draw a cotter foundation bolt to take a load of 90 kN. Assume the permissible stresses as follows : σt = 50 MPa, τ = 60 MPa and σc = 100 MPa.	Understand	CO 3	AME012.15
6	The pull in the tie rod of a roof truss is 44 kN. Design a suitable adjustable Screw joint. The permissible tensile and shear stresses are 75 MPa and 37.5 MPa respectively. Draw full size two suitable views of the joint.	Understand	CO 3	AME012.15
7	Sketch two views of a knuckle joint and write the equations showing the strength of joint for the most probable modes of failure.	Understand	CO 3	AME012.15
8	Why gibs are used in a cotter joint? Explain with the help of a neat sketch the use of single and double gib.	Understand	CO 3	AME012.15
9	Design a cotter joint to connect two mild steel rods for a pull of 30 kN. The maximum permissible stresses are 55 MPa in tension ; 40 MPa in shear and 70 MPa in crushing. Draw a neat sketch of the joint designed.	Understand	CO 3	AME012.15
10	The big end of a connecting rod is subjected to a load of 40 kN. The diameter of the circular partadjacent to the strap is 50 mm. Design the joint assuming the permissible tensile stress in the strap as 30 MPa and permissible shearstress in the cotter and gib as 20 MPa.	Understand	CO 3	AME012.15

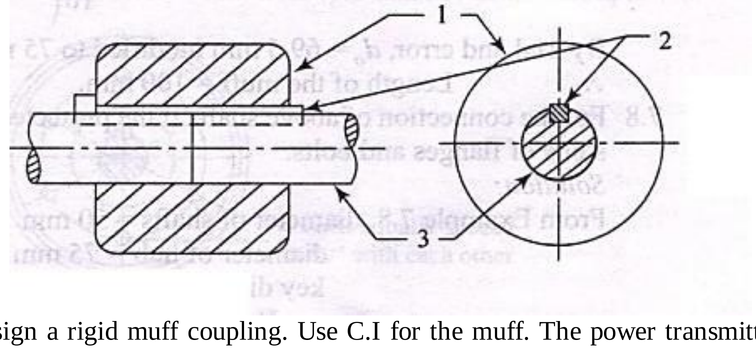
UNIT-IV

DESIGN OF SHAFTS AND SHAFTS COUPLINGS

PART – A (SHORT ANSWER QUESTIONS)

S No	Question	Blooms Taxonomy level	Course Outcomes (COs)	Course Learning Outcomes (CLOs)
1	Define shaft	Remember	CO 4	AME012.16
2	Write the application of shafts	Remember	CO 4	AME012.16

3	Explain the materials used for making shafts	Remember	CO 4	AME012.16
4	Define hollow shafts	Remember	CO 4	AME012.16
5	Define equivalent bending moment	Remember	CO 4	AME012.16
6	Define equivalent twisting moment	Remember	CO 4	AME012.17
7	Define coupling	Remember	CO 4	AME012.17
8	Explain classification coupling	Remember	CO 4	AME012.17
9	Explain functions of coupling	Remember	CO 4	AME012.17
10	Write the applications of coupling	Remember	CO 4	AME012.18
11	Explain about universal coupling	Remember	CO 4	AME012.18
12	Explain about bushed pin flexible coupling	Remember	CO 4	AME012.18
13	Write merits and demerits bushed pin flexible coupling	Remember	CO 4	AME012.18
14	Define clutch	Remember	CO 4	AME012.18
15	Define rigid coupling	Remember	CO 4	AME012.19
16	Write the difference between shaft and axle	Remember	CO 4	AME012.19
17	Define torsional rigidity	Remember	CO 4	AME012.19
18	Define lateral rigidity	Remember	CO 4	AME012.20
19	Explain causes for failure of shaft	Remember	CO 4	AME012.20
20	Define transmission types of shaft	Remember	CO 4	AME012.20
	Part - B (Long Answer Questions)			
1	A steel spindle transmits 4 kW at 800 r.p.m. The angular deflection should not exceed 0.25°per metre of the spindle. If the modulus of rigidity for the material of the spindle 84GPa . find the diameter of the spindle.	Understand	CO 4	AME012.16
2	A 600 mm diameter pulley driven by a horizontal belt transmits power to a 200 mm diameter pinion. The pulley has a mass of 90 kg, Km = 2, Kt = 1.5 and allowable shear stress of the material is 40 MPa. Find the diameter of the shaft.	Understand	CO 4	AME012.16
3	A shaft is supported by two bearings placed 1 m apart. A 600 mm diameter pulley is mounted at a distance of 300 mm to the right of left hand bearing and this drives a pulley directly below it with the help of belt having maximum tension of 2.25 kN. Another pulley 400 mm diameter is placed 200 mm 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 is180° and μ = 0.24. Determine the suitable diameter for a solid shaft, allowing working stress of63 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.	Understand	CO 4	AME012.16
4	A shaft made of mild steel is required to transmit 100 kW at 300 r.p.m. Thesupported length of the shaft is 3 metres. It carries two pulleys each weighing 1500 N supported at adistance of 1 metre from the ends respectively. Assuming the safe value of stress, determine thediameter of the shaft.	Understand	CO 4	AME012.17
5	A shaft is subjected to loads as shown in Fig. Gear *C* is connected to the other gear such that 50 kW is transmitted at 100 r.p.m. The pressure angle of the involute gear teeth is 20^0. The ratio of belt tensions for pulley *A* is 2:1, the diameter of pulley being 750 mm. the sprocket *B* is 500 mm diameter with negligible tension in the chain on the slack side. The diameter of gear *C* is 300mm. The power transmitted by chain drive is 20 kW, the remaining being transmitted by the belt drive. Find diameter of the shaft if F.S=3, K_m = 1.5, K_t = 1.2 and S_y = 350 MPa for shaft material. 	Understand	CO 4	AME012.18
6	Calculate the diameter of the solid circular shaft shown in Fig. to transmit 45 KWat1000rpmthepressureangleoftheinvolutebevelandspurgearsis 20^0. Diameter of bevel gear *C*=500mm and the diameter of spur pinion *D*=300mm. Assume complete power being transmitted and safe shear stress for shaft equal to 60 MPa.	Understand	CO 4	AME012.18
7	Compute the diameter of a solid shaft which has to transmit 16kW power at 300rpm.Ultimate shear stress per shaft material is 35oN/mm2 and factor of safety for design is 6. If a hollow shaft replaces the solid shaft, find the inside and outside diameters if the ratio is 0.5.	Understand	CO 4	AME012.18
8	An electric motor drives a machine through a pair of spur gears. The pinion is mounted on motor shaft and overhangs by 200 mm from the	Understand	CO 4	AME012.18

	nearestBearing.Thepinionhas20teethof10mmmoduleand20^{0}involuteprofile Design the motor shaft to transmit 15 kW at 1200 rpm. Use safe shear stress value of 400 MPa, K_m = 1.2 and K_t =1.			
9	Design a hollow shaft required to transmit 12 MW at a speed of 300 rpm. The maximum shear stress allowed in the shaft is 80 MPa and the ratio of inner diameter to outer diameter 0.75.	Understand	CO 4	AME012.18
10	How is the shaft designed when it is subjected to twisting moment only?	Understand	CO 4	AME012.18
11	Design a shaft to transmit power from an electric motor to a lathe headstock through a pulley by means of a belt drive. The pulley weighs 200N and is located at 100mm from the centre of the bearing. Diameter of the pulley 200mm. Maximum power transmitted is 1.5HP at 120 rpm. Angle of lap of belt 1800. Coefficient of friction between belt and pulley 0.3. Shock factor in bending 1.5 shock factors in twisting 2.0. Allowable shear stress in the shaft 35N/mm2.	Understand	CO 4	AME012.18
12	In an axial flow rotary compressor, the shaft is subjected to maximum twisting moment of 1500 N-m and a maximum bending of 3000 N-m. Neglecting the axial load on the shaft determine the diameter of the shaft, if the allowable shear stress is 45 N/mm^2. Assume Kb=1.5 and Kt =1.2 If the shaft is to be a hollow one with di / do= 0.6, what will be the material saving in the hollow shaft. It is subjected to the same loading and of the same material as the solid shaft.	Understand	CO 4	AME012.19
13	Compare the weight, strength, and stiffness of a hallow shaft of the same external diameter as that of solid shaft. The inside diameter of the hallow shaft being 0.6 times the external diameter. Both the shafts have same material and length.	Understand	CO 4	AME012.19
14	Computethediameterofasolidshaftwhichhastotransmit16kWpowerat300rpm.Ultimate shear stress per shaft material is 350N/mm^2 and factor of safety for design is 6.	Understand	CO 4	AME012.19
15	A shaft is supported on bearings A and B, 800 mm between centres. A 20°straight tooth spur gear having 600 mm pitch diameter, is located 200 mm to the right of the left hand 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 weighs 2000 N. 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.	Understand	CO 4	AME012.20
16	A mild steel shaft transmits 20 kW at 200 r.p.m. It carries a central load of 900N and is simply supported between the bearings 2.5 metres 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 exceed56 MPa. What size of the shaft will be required, if it is subjected to gradually applied loads?	Understand	CO 4	AME012.20
17	A hollow shaft of 0.5 m outside diameter and 0.3 m inside diameter is used to drive a propeller of a marine vessel. The shaft is mounted on bearings 6 metre apart and it transmits5600 kW at 150 r.p.m. The maximum axial propeller thrust is 500 kN and the shaft weighs 70 kN. Determine : 1. The maximum shear stress developed in the shaft, and 2. The angular twist between the bearings.	Understand	CO 4	AME012.20
18	 Design a rigid muff coupling. Use C.I for the muff. The power transmitted is 25kW at 300 r.p.m. Sut = 200 MPa, F.S = 6, use 30C8 steel for the shaft consider Sy = 330 MPa and F.S = 4	Understand	CO 4	AME012.20
19	Design a bushed pin type of flexible coupling to connect the motor shaft and pump shaft of 50 mm and 40 mm diameter respectively when 15kW power is to be transmitted at 1200 r.p.m, the permissible bearing pressure for pinion 0.3	Understand	CO 4	AME012.20

	MPa.			
20	Design and make a neat dimensioned sketch of a muff coupling which is used to connect two steel shafts transmitting 40 kW at 350 r.p.m. The material for the shafts and key is plain carbon steel for which allowable shear and crushing stresses may be taken as 40 MPa and 80 MPa respectively. The material for the muff is cast iron for which the allowable shear stress may be assumed as 15 MPa.	Understand	CO 4	AME012.20
	PART - C (ANALYTICAL QUESTIONS)			
1	A steel spindle transmits 4 kW at 800 r.p.m. The angular deflection should not exceed 0.25° per metre of the spindle. If the modulus of rigidity for the material of the spindle is 84 GPa, find the diameter of the spindle and the shear stress induced in the spindle.	Understand	CO 4	AME012.15
2	Compare the weight, strength and stiffness of a hollow shaft of the same external diameter as that of solid shaft. The inside diameter of the hollow shaft being half the external diameter. Both the shafts have the same material and length.	Understand	CO 4	AME012.15
3	A line shaft is to transmit 30 kW at 160 r.p.m.It is driven by a motor placed directly under it by means of a belt running on a 1 m diameter pulley keyed to the end of the shaft. The tension in the tight side of the belt is 2.5 times that in the slack side and the centre of the pulley over-hangs 150 mm beyond the centre line of the end bearing. Determine the diameter of the shaft, if the allowable shear stress is56 MPa and the pulley weighs 1600 N.	Understand	CO 4	AME012.16
4	The internal diameter of a hollow shaft is 2/3 rd of its external diameter. Compare the strength and stiffness of the shaft with that of a solid shaft of the same material.	Understand	CO 4	AME012.17
5	Under what circumstances are hollow shafts preferred over solid shafts? Give any two examples where hollow shafts are used. How they are generally manufactured?	Understand	CO 4	AME012.18
6	A shaft is required to transmit 1 MW power at 240 r.p.m. The shaft must not twist more than 1 degree on a length of 15 diameters. If the modulus of rigidity for material of the shaft is 80 GPa, find the diameter of the shaft and shear stress induced.	Understand	CO 4	AME012.18
7	A marine type flange coupling is used to transmit 3.75 MW at 150 r.p.m. 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.	Understand	CO 4	AME012.19
8	An universal coupling is used to connect two mild steel shafts transmitting a torque of 6000 N-m. Assuming that the shafts are subjected to torsion only, find the diameter of the shaft and the pin. The allowable shear stresses for the shaft and pin may be taken as 55 MPa and 30 MPa respectively.	Understand	CO 4	AME012.19
9	Design a compression coupling for a shaft to transmit 1300 N-m. The allowable shear stress for theshaft 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.	Understand	CO 4	AME012.19
10	Write short note on the splined shaft covering the points of application, different types and method of manufacture.	Understand	CO 4	AME012.20

UNIT-V

DESIGN OF SPRINGS

PART – A (SHORT ANSWER QUESTIONS)

S No	Question	Blooms Taxonomy level	Course Outcomes (COs)	Course Learning Outcomes (CLOs)
1	Define spring	Remember	CO 5	AME012.21
2	Explain functions of spring	Remember	CO 5	AME012.21
3	Explain why the circular cross section used mostly for spring	Remember	CO 5	AME012.22
4	Define flat springs	Remember	CO 5	AME012.22
5	Define spiral springs	Remember	CO 5	AME012.22
6	Define helical springs	Understand	CO 5	AME012.22
7	Define spring index	Remember	CO 5	AME012.23
8	Define free length	Remember	CO 5	AME012.23
9	Define solid length	Understand	CO 5	AME012.23
10	Define active number coils	Remember	CO 5	AME012.23
11	Define the phenomenon of surging in springs	Remember	CO 5	AME012.23
12	Explain about ground ends	Understand	CO 5	AME012.23
13	Explain about square ends	Remember	CO 5	AME012.24
14	Define methods to avoid surge in springs	Understand	CO 5	AME012.24
15	Define leaf springs	Remember	CO 5	AME012.24
16	Explain why leaf springs are made in layers instead of single plate	Remember	CO 5	AME012.24
17	Define helical torsion spring	Remember	CO 5	AME012.25
18	Explain spiral torsion spring	Remember	CO 5	AME012.25
19	Define Wahls factor	Remember	CO 5	AME012.25
20	Define spring rate	Remember	CO 5	AME012.25
Part - B (Long Answer Questions)				
1	A railway wagon of mass 20000 kg moving with a velocity of 2 m/s is brought to rest by two buffers of a spring of diameter 300 mm. The maximum deflection of the spring is 200 mm. permissible shear stress is 600 MPa. Find the dimensions of each spring.	Understand	CO 5	AME012.22
2	Design a close coiled helical spring subjected to a tensile load of magnitude varying from 2500 N to 3000 N. The axial deflection of spring for this range of load is 6.5 mm. Design the spring, talking the spring index as 6 and the safe shear stress for material of the spring equal to 465 MPa.	Understand	CO 5	AME012.22
3	A load of 5 kN is dropped from a height of 50 mm axially on the spring of a wire of diameter 12 mm, spring index equal to 6 and the number of active coils as 8. Find the stress induced in the spring	Understand	CO 5	AME012.22
4	A helical spring is subjected to a continuously varying load. A number 7 oil tempered wire is used with the mean diameter of the coil as 26 mm. The maximum and minimum force acting on the spring is 400 N and 260 N respectively and deflection during this variation is 8mm. Find the factor of safety and number of active turns. For No. 7 wire oil tempered S_u = 1400MPa, S_{ys} =0.4 S_u, S_{es}=0.23S_u and d=4.5mm.	Understand	CO 5	AME012.22
5	A helical compression spring carries a fluctuating load varying from 428 N to 642 N. The spring index is 6 and factor of safety is 1.5. S_{ys}= 648 MPa, S_{es} = 375 MPa. Calculate the spring wire diameter . the number of effective turns if deflection due to variation in load is 4mm.	Understand	CO 5	AME012.23
6	Design the cantilever leaf spring to absorb 600 N.m energy without exceeding a deflection of 150 mm and permissible stress of 800 MPa. The effective length of the spring is 500 mm. E=0.2 x 10^6MPa	Understand	CO 5	AME012.23
7	A Close coiled helical compression spring is used in the spring loaded safety valve of 80mm diameter. The blow off pressure is 1.4 MPa and maximum lift is 18 mm. Material of the spring is oil quenched steel with a safe shear stress of 500 MPa. Spring index is 6. The normal pressure inside the boiler is 1.00 MPa	Understand	CO 5	AME012.23

	and G=0.84 x 10^5MPa. Design the spring			
8	Design a tension spring for a spring balance when the maximum load to be weighed is 1000N. Length of the scale is 100mm and the spring index is 5. The material has the maximum permissible shear stress of 600 MPa and G=0.8 x 10^5MPa.	Understand	CO 5	AME012.23
9	The blow off pressure for a safety valve is 1.2 MPa with the maximum lift of the valve as 10 mm. The valve of diameter 69 mm is loaded with a spring of spring index 5.5andaninitialcompressionof40mm.Maximum Permissible shear stress for the spring material is 500 MPa, G=0.8 x 10^5MPa. Design the spring.	Understand	CO 5	AME012.23
10	A helical compression spring is subjected to a load varying between 800 and 1500 N. The material used is oil tempered cold drawn wire having Sys = 700 MPa and Ses = 356 MPa. Find the diameter of the wire and the number of coils if C=5 and N=2.5	Understand	CO 5	AME012.23
11	A close coiled helical compression spring has a mean coil diameter of 60 mm and the diameter of the wire is 10mm. Number of active and inactive coil turns is 11 and 2 respectively. Free length of the spring is 210mm. Decide the maximum load that can be applied on the spring if the minimum load is 1/3 of the maximum load. Use F.S=1.5,Sys=700MPaandSes= 1360 MPa.	Understand	CO 5	AME012.23
12	a) A helical spring is subjected to loads ranging from 2kN to 2.5kN. The axial compression of the spring over the above load range is approximately 5 mm. Assume Spring-index of 6, design the spring. b) What is nipping in a leaf spring? Discuss its role.	Understand	CO 5	AME012.24
13	A semi - elliptic spring has an overall length of 1.2m and sustains a load of 80k N at its centre. The spring has 3 extra full length leaves and 13 graduated leaves with a central band of 120mm wide. All the leaves are to be stressed equally without exceeding 450MPa, when fully loaded. The total depth of spring is twice the width. If the young's modulus is 210Gpa. Determine i. The thickness and width of leaves. ii. The nip to be provided for pre-stressing. iii. The load exerted on the clipping bolts after the spring is assembled.	Understand	CO 5	AME012.24
14	A helical spring is to support a load of 1000N. The spring is guided by a rod of 50mm diameter. The spring undergoes a deflection of 40 mm under the load. Determine the diameter of the wire and the number of turns required, Use C-60 steel with a factor of safety 2.	Understand	CO 5	AME012.25
15	A compression coil spring made of an alloy steel is having the following Specifications: Mean diameter of coil = 50 mm; Wire diameter = 5 mm; Number of active coils = 20. If this spring is subjected to an axial load of 500 N; calculate the maximum shear stress(neglect the curvature effect) to which the spring material is subjected.	Understand	CO 5	AME012.25
16	Design a spring for a balance to measure 0 to 1000 N over a scale of length80 mm. The spring is to be enclosed in a casing of 25 mm diameter. The approximate number of turn is 30. The modulus of rigidity is 85 kN/mm^2. Also calculate the maximum shear stress induced.	Understand	CO 5	AME012.25
17	Design a helical compression spring for a maximum load of 1000 N for a deflection of 25 mm using the value of spring index as 5. The maximum permissible shear stress for spring wire is 420 MPa and modulus of rigidity is84 kN/mm2. Take Wahl's factor, K = 4C -1/ 4 C-4 + 0.615/C, where C = Spring index.	Understand	CO 5	AME012.25
18	Design a spring for a balance to measure 0 to 1000 N over a scale of length80 mm. The spring is to be enclosed in a casing of 25 mm diameter. The approximate number of turns is 30. The modulus of rigidity is 85 kN/mm^2. Also calculate the maximum shear stress induced.	Understand	CO 5	AME012.25
19	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/mm2.	Understand	CO 5	AME012.25
20	At the bottom of a mine shaft, a group of 10 identical close coiled helical	Understand	CO 5	AME012.25

	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 75 kN, while the counter weight has a weight of 15 kN. If the loaded cage falls through a height of 50 metres from rest. Find the maximum stress induced in each spring if it is made of 50 mm diameter steel rod. The spring index is 6 and the number of active turns in each spring is 20. Modulus of rigidity, G = 80 kN/mm2.			
	PART - C (ANALYTICAL QUESTIONS)			
1	A close coiled helical compression spring of 12 active coils has a spring stiffness of k. It is cut into two springs having 5 and 7 turns. Determine the spring stiffness of resulting springs.	Understand	CO 5	AME012.25
2	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 bending stress induced and the angular deflection of the spring in degrees. The 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.	Understand	CO 5	AME012.25
3	A spiral spring is made of a flat strip 6 mm wide and 0.25 mm thick. The length of the strip is 2.5 metres. Assuming the maximum stress of 800 MPa to occur at the point of greatest bending moment, calculate the bending moment, the number of turns to wind up the spring and the strain energy stored in the spring. Take E = 200 kN/mm2.	Understand	CO 5	AME012.25
4	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/mm2.	Understand	CO 5	AME012.25
5	A load of 2 kN is dropped axially on a close coiled helical spring, from a height of 250 mm. The spring has 20 effective turns, and it is made of 25 mm diameter wire. The spring index is 8. Find the maximum shear stress induced in the spring and the amount of compression produced. The modulus of rigidity for the material of the spring wire is 84 kN/mm2.	Understand	CO 5	AME012.25
6	Design a concentric spring for an air craft engine valve to exert a maximum force of 5000 N under a deflection of 40 mm. Both the 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.	Understand	CO 5	AME012.25
7	The free end of a torsional spring deflects through 90° when subjected to a torque of 4 N-m. The spring index is 6. Determine the coil wire diameter and number of turns with the following data : Modulus of rigidity = 80 GPa ; Modulus of elasticity = 200 GPa; Allowable stress = 500 MPa.	Understand	CO 5	AME012.25
8	Prove that in a spring, using two concentric coil springs made of same material, having same length and compressed equally by an axial load, the loads shared by the two springs are directly proportional to the square of the diameters of the wires of the two springs.	Understand	CO 5	AME012.25
9	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 of mean diameter 40 mm and wire diameter 5mm. The inner spring has 8 coils of 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/mm^2.	Understand	CO 5	AME012.25
10	A rail wagon of mass 20 tonnes is moving with a velocity of 2 m/s. It is brought to rest by two buffers with springs of 300 mm diameter. The maximum deflection of springs is 250 mm. The allowable shear stress in the spring material is600 MPa. Design the spring for the buffers.	Understand	CO 5	AME012.25

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