BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: B.TECH. **SEMESTER : IVth/ADD**
BRANCH: MECHANICAL **SESSION : SP/2024**

SUBJECT: ME211 MACHINE DESIGN

TIME: 3 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Machine Design Data hand book to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	What are the causes of stress concentration and how can it be reduced?	[5]	CO1	L1
Q.1(b)	The work cycle of a mechanical component subjected to completely reversed bending stresses consists of the following three elements: (i) ± 350 N/mm^2 for 85% of time (ii) ± 400 N/mm^2 for 12% of time (iii) ± 500 N/mm^2 for 3% of time The material for the component is 50C4 (S_{ut} = 660 N/mm^2) and the corrected endurance limit of the component is 280 N/mm^2. Determine the life of the component.	[5]	CO1	L3
Q.2(a)	The structural connection shown in Fig.1 below is subjected to an eccentric force P of 20 kN with an eccentricity of 500 mm from the CG of the bolts. The centre distance between bolts 1 and 2 is 150 mm, and the centre distance between bolts 1 and 3 is 175 mm. All the bolts are identical. The bolts are made from plain carbon steel 30C8 (S_{yt} = 400 N/mm^2) and the factor of safety is 2.5. Determine the size of the bolts.	[5]	CO2	L2

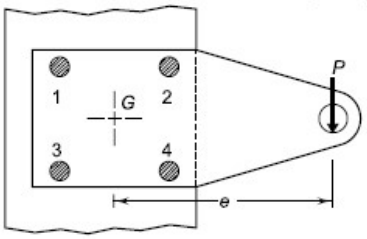

Fig.1

Q.2(b)	A steel plate, 80 mm wide and 10 mm thick, is joined to another steel plate by means of a single transverse and double parallel fillet welds, as shown in Fig.2. The strength of the welded joint should be equal to the strength of the plates to be joined. The permissible tensile and shear stresses for the weld material and the plates are 100 and 70 N/mm^2 respectively. Find the length of each parallel fillet weld. Assume that the tensile force passes through the center of gravity of three welds.	[5]	CO2	L2

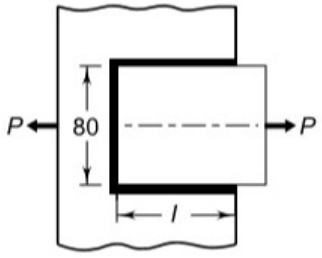

Fig.2

PTO

Q.3(a)	What is the difference between the clutch and the brake considering its initial & final condition?	[5]	CO3	L1
Q.3(b)	A single plate clutch consists of one pair of contacting surfaces. The inner and outer diameters of the friction disk are 125 and 250 mm respectively. The coefficient of friction is 0.25 and the total axial force is 15 kN. Calculate the power transmitting capacity of the clutch at 500 rpm using: (i) uniform wear theory; and (ii)uniform pressure theory	[5]	CO3	L3
Q.4(a)	The following data is given for a 360° hydrodynamic bearing: radial load = 3.2 kN journal speed = 1490 rpm journal diameter = 50 mm bearing length = 50 mm radial clearance = 0.05 mm viscosity of lubricant = 25 cP Assuming that the total heat generated in the bearing is carried by the total oil flow in the bearing, calculate (i) coefficient of friction; (ii) power lost in friction; (iii) minimum oil film thickness; (iv) flow requirement in litres/min; and (v) temperature rise.	[5]	CO4	L3
Q.4(b)	A helical compression spring, made of circular wire, is subjected to an axial force, which varies from 3.5 kN to 4.5 kN. Over this range of force, the deflection of the spring should be approximately 5 mm. The spring index can be taken as 5. The spring has square and ground ends. The spring is made of patented and cold-drawn steel wire with ultimate tensile strength of 1050 N/mm^2 and modulus of rigidity of 81370 N/mm^2. The permissible shear stress for the spring wire should be taken as 50% of the ultimate tensile strength. Design the spring.	[5]	CO4	L2
Q.5(a)	Why is the tangential component of gear tooth force called useful component while the radial component as separating component? Explain with neat sketches.	[5]	CO5	L2
Q.5(b)	A pair of spur gears with 20° full-depth involute teeth consists of a 19 teeth pinion meshing with a 40 teeth gear. The pinion is mounted on a crankshaft of 7.5 kW single cylinder diesel engine running at 1500 rpm. The driven shaft is connected to a two-stage compressor. Assume the service factor as 1.5. The pinion as well as the gear is made of steel 40C8 (S_{ut} = 600 N/mm^2). The module and face width of the gears are 4 and 40 mm respectively. (i) Using the velocity factor to account for the dynamic load, determine the factor of safety. (ii) If the factor of safety is two for pitting failure, recommend surface hardness for the gears. (iii) If the gears are machined to meet the specifications of Grade 8, determine the factor of safety for bending using Buckingham's equation for dynamic load.	[5]	CO5	L3

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