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

CLASS: B.TECH.   SEMESTER : IVth
BRANCH: MECHANICAL   SESSION : SP/2023

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. Design Data hand book to be supplied to the candidates in the examination hall.

			CO	BL

Q.1(a) State distortion energy theory of failure. [2] CO1 L1

Q.1(b) A cantilever beam made of cold drawn steel 4OC8 (S_{ut} = 600 N/mm^2 and S_{yt} = 380 N/mm^2) [8] CO3 L3
is shown in Fig. 1. The force P acting at the free end varies from -50 N to +150 N. The expected reliability is 90% and the factor of safety is 2. The notch sensitivity factor at the fillet is 0.9. Determine the diameter "d" of the beam at the fillet cross-section and also draw the modified Goodman diagram (Take K_a = 0.77, K_b = 0.85, K_c = 0.897, K_t = 1.44)
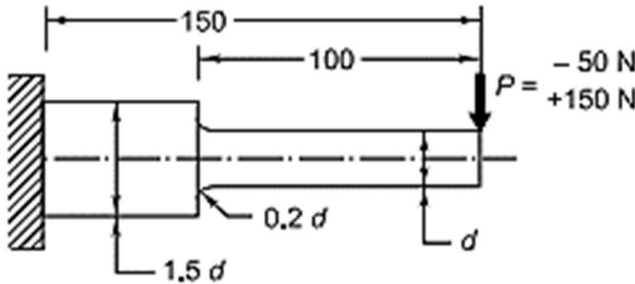

Fig.1

Q.2(a) Explain transverse and parallel fillet joint with neat sketches. [2] CO2 L1
                                                                                       L3

Q.2(b) The structural connection shown in Fig. 2 is subjected to an eccentric force P of 10 kN [8] CO3
with an eccentricity of 500 mm from the CG of the bolts. The centre distance between bolts 1 and 2 is 200 mm, and the centre distance between bolts 1 and 3 is 150 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.
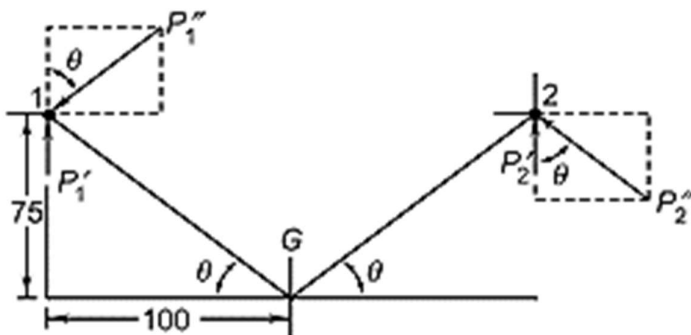

Fig. 2

Q.3(a) What is the difference between the clutch and the brake? [2] CO1 L1
                                                                                L3

Q.3(b) Derive an expression for torque transmitting capacity in clutch based on uniform pressure [8] CO3
and uniform wear theory.

Q.4(a) What is difference between rolling-contact and sliding-contact bearing? [2] CO1 L1

L3

Q.4(b) A helical compression spring, made of circular wire, is subjected to an axial force, which [8] CO3
varies from 2.5 kN to 3.5 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 and draw the spring and calculate:
(i) Wire diameter (ii) mean coil diameter (iii) number of active coils (iv) total number of
coils (v) solid length of the spring (vi) free length of the spring (vii) required spring rate
(viii) actual spring rate

Q.5(a) Why is the tangential component of gear tooth force called useful component while the [2] CO2 L1
radial component as separating component? Explain with neat sketches. L3

Q.5(b) A pair of spur gears with 20° full-depth involute teeth. The input shaft rotates at 720 rpm [8] CO3
and receives 5 kW power through a flexible coupling. The speed of the output shaft should
be 144 rpm. The pinion as well as the gear are made of steel Fe 410 (S_{ut} = 410 N/mm^2).
The service factor for the application is 1.25. The gears are machined to meet the
specifications of Grade 6.
 (i) Determine static load and the dynamic load by Buckingham's equation. Also, calculate
the beam strength and the correct value of factor of safety based on beam strength.
(ii) Using a factor of safety of 2 for wear strength, specify the surface hardness for gears.

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