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

CLASS: B.TECH. **SEMESTER : IVth**
BRANCH: MECHANICAL ENGINEERING **SESSION : SP/2025**

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 handbook to be supplied to the candidates in the examination hall.**

			CO	BL
Q.1(a)	Explain fatigue failure with examples. How does it relates to the endurance limit?	[5]	CO1	L2
Q.1(b)	A cantilever spring made of 10 mm diameter wire is shown in Fig. 1. The wire is made of stainless steel (S_{ut} = 860 N/mm^2 and S_{yt} = 690 N/mm^2). The force P acting at the free end varies from 75 N to 150 N. The surface finish of the wire is equivalent to the machined surface. There is no stress concentration, and the expected reliability is 50%. Calculate the number of stress cycles likely to cause fatigue failure.	[5]	CO1	L3
Q.2(a)	Two flat plates subjected to a tensile force P are connected by means of double-strap butt joint. The force P is 250 kN and the width of the plate w is 200 mm. The rivets and plates are made of the same steel and the permissible stresses in tension, compression and shear are 70, 100, and 60 N/mm^2 respectively. Calculate the efficiency of the joint?	[5]	CO2	L2
Q.2(b)	The structural connection shown in Fig.2 below is subjected to an eccentric force P of 20 kN with an eccentricity of 400 mm from the CG of the bolts. The centre distance between bolts 1 and 2 is 100 mm, and the centre distance between bolts 1 and 3 is 200 mm. All the bolts are identical. The bolts are made from plain carbon steel (S_{yt} = 400 N/mm^2) and the factor of safety is 2. Determine the size of the bolts.	[5]	CO2	L3
Q.3(a)	A plate clutch consists of one pair of contacting surfaces. The inner and outer diameters of the friction disk are 100 and 200 mm respectively. The coefficient of friction is 0.2 and the permissible intensity of pressure is 5 N/mm^2. Calculate the power transmitting capacity of the clutch at 750 rpm using: (i) uniform wear theory (ii) uniform pressure theory	[5]	CO3	L2
Q.3(b)	A mass of 2500 kg is lowered at a velocity of 1.5 m/s from the drum as shown in Fig.3. The mass of the drum is 50 kg and its radius of gyration can be taken as 0.7 m. On applying the brake, the mass is brought to rest in a distance of 0.5 m. Calculate the energy absorbed and torque capacity of the brake.	[5]	CO3	L1
Q.4	A helical compression spring is used to absorb the shock. The initial compression of the spring is 30 mm and it is further compressed by 50 mm while absorbing the shock. The spring is to absorb 250 Joule of energy during the process. The spring index can be taken as 6. The spring is made of patented and cold-drawn steel wire with an ultimate tensile strength of 1500 N/mm2 and modulus of rigidity of 81370 N/mm2. The permissible shear stress for the spring wire should be taken as 30% of the ultimate tensile strength. Design the spring.	[10]	CO4	L2

PTO

Q.5 A pair of spur gears with 20°full-depth involute teeth consist 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 (Sut = 600 N/mm2). The module and face width of the gears are 4 and 40 mm respectively. [10] CO5 L3

(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.

(iv) Is the gear design satisfactory? If not, what is the method to satisfy the design conditions?

How will you modify the design?

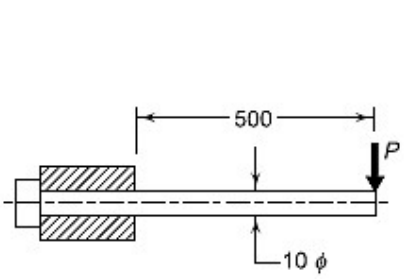

Fig. 1

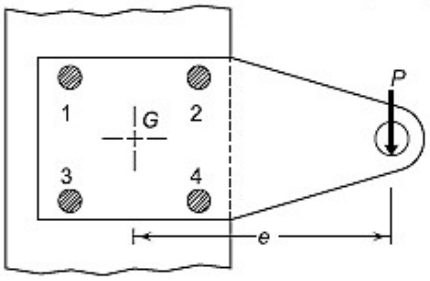

Fig. 2

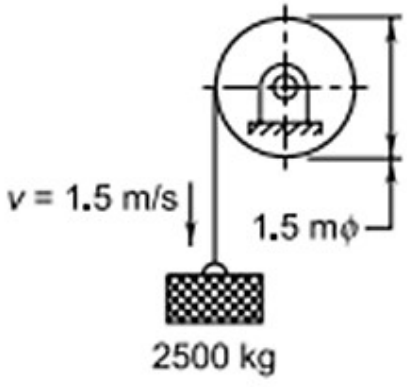

Fig. 3

:::::29/04/2025 M:::::