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

CLASS: BTECH **SEMESTER : II**
BRANCH: MECH/CIVIL/PROD/CHEMICAL/BIOTECH **SESSION : SP/2025**

SUBJECT: ME24101 BASICS OF MECHANICAL ENGINEERING

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. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	Find the forces developed in the members (1), (2) and (3) along the section as shown in Fig. 1.	[5]	CO1 CO2 CO3	BL3

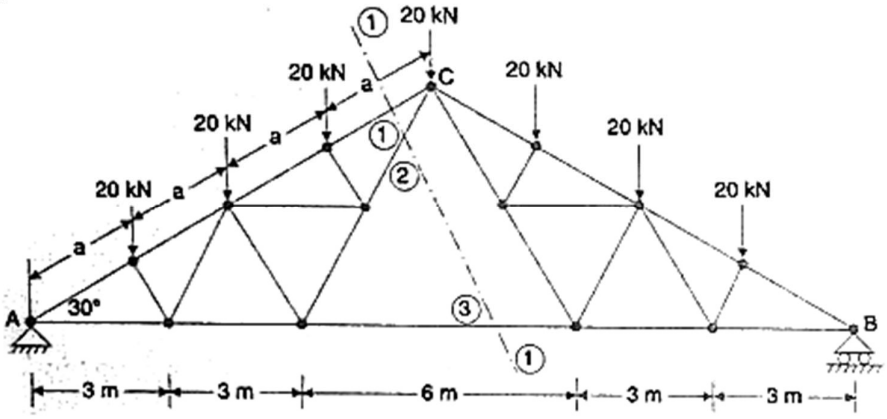

Fig. 1

Q.1(b)	At a point in a loaded material, consider a Cartesian coordinate system with mutually perpendicular axes labeled as 1, 2, and 3. The normal stresses along directions 1, 2 and 3 are denoted by σ_1, σ_2 and σ_3 while normal strains are ϵ_1, ϵ_2 and ϵ_3 respectively. Show that normal stress $\sigma_1 = 2G(B\epsilon_v + \epsilon_1)$ where G = shear modulus, $B = \{\nu/(1-2\nu)\}$ and ϵ_v= volumetric strain.	[5]	CO1 CO2 CO3	BL3

Q.2(a)	In the slider crank mechanism shown in Fig. 2, the crank is rotating at a constant speed of 480 rpm. The connecting rod is 600 mm long, and the crank is 100 mm long. For an angle of 30°, determine the absolute velocity of the crosshead P by using instant centers.	[5]	CO1 CO2 CO3	BL3

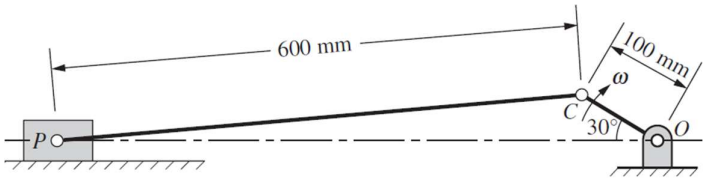

Fig. 2

Q.2(b)	Explain why polar coordinates are preferred for analyzing plane curvilinear motion in systems involving combined circular and radial motion. Also derive the general expressions (not for any specific case) for velocity and acceleration in polar coordinates and briefly explain the physical significance of each term in the derived expressions.	[5]	CO1 CO2	BL2

PTO

Q.3(a)	A manually operated screw press is used in a bookbinding workshop to apply pressure on a stack of books during the gluing and setting process. The screw has a double-threaded square thread with a pitch of 4 mm and a mean radius of 25 mm. The coefficient of friction between the threads is 0.3. If the press is required to exert a compressive force of 500 N on the books: (a) Calculate the torque required to rotate the screw. (b) State the equation used and briefly justify its relevance by explaining the direction of motion, the effect of friction, and the role of thread type.	[5]	CO1 CO2 CO3	BL3
Q.3(b)	In mechanical systems, wedges are frequently used for tightening or holding objects in place by relying on friction at both the upper (object-wedge) and lower (wedge-ground) surfaces. Based on the observation of slipping tendencies at both contact surfaces, find the condition for selecting a suitable wedge angle. Explain how this angle ensures equilibrium and prevents the wedge from slipping away, considering the role of the angle of friction.	[5]	CO1 CO2 CO3	BL3
Q.4(a)	Imagine a situation where diesel is accidentally filled into a petrol engine vehicle. Analyze what would happen in this case, and using your understanding of internal combustion engine fundamentals, explain how this mistake highlights the key differences between Spark Ignition (SI) and Compression Ignition (CI) engines in terms of fuel type, ignition method, compression ratio, and combustion behavior.	[5]	CO1 CO2	BL2
Q.4(b)	Discuss the roles of boiler mountings and accessories in maintaining the safety and efficiency of a boiler. Explain how the failure of one component, such as the safety valve or economizer, can impact the overall performance of the system.	[5]	CO1 CO2	BL1
Q.5(a)	In designing a hybrid renewable energy system using solar, wind, and hydropower in a coastal region, discuss the challenges posed by the intermittent nature of wind and solar energy. How would you manage energy storage to ensure a stable power supply? Draw a schematic of the hybrid system and highlight the key components involved in energy storage.	[5]	CO1 CO2 CO4	BL4
Q.5(b)	In the context of daily life, compare the advantages and disadvantages of renewable energy (solar, wind, and hydropower) with non-renewable energy sources (coal, oil, and natural gas). Discuss how the adoption of renewable energy in households can contribute to long-term sustainability and reduce dependence on non-renewable resources. What challenges might arise in this transition?	[5]	CO1 CO2	BL2

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