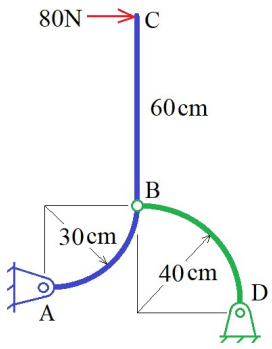
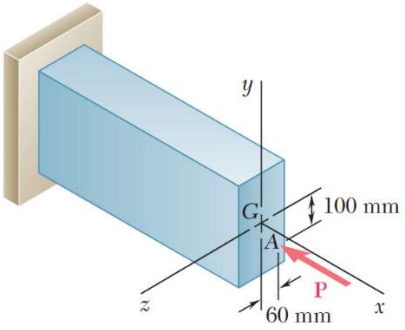
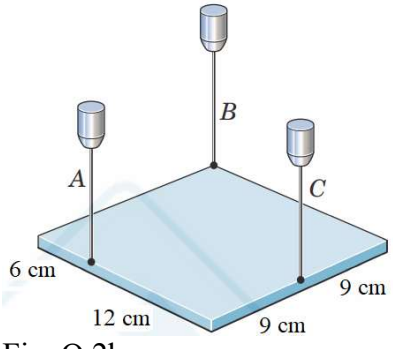
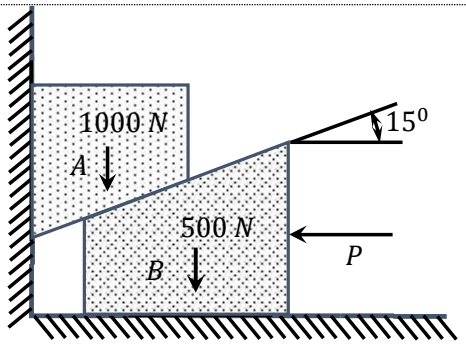
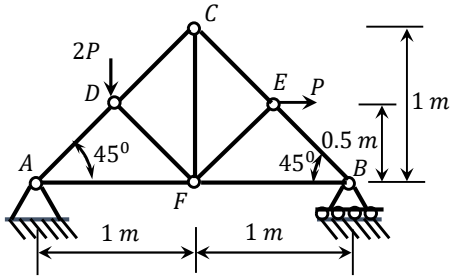
ENGINEERING MECHANICS
XEC 01

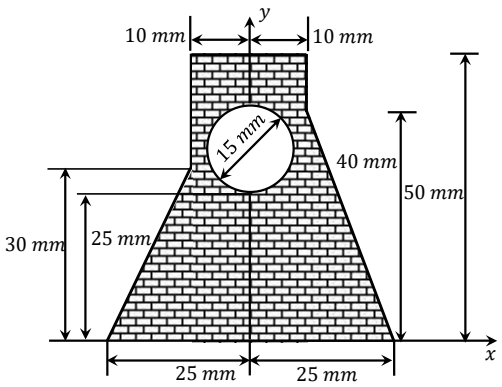
TIME ……TWO HOURS FULL MARKS ……60
[Date of Exam 22-03-2022, Exam duration 10 am to 12 noon, Online submission by 12:15 pm]

Group A — Answer any three out of five

Sl No.	Question		Marks
1a	State the necessary and sufficient condition(s) of equilibrium of several forces in a plane.		2
1b	The lever ABC is pin supported at A and connected with a short circular link at point B. Neglecting friction find the reaction force on the lever at A.	 Fig. Q 1b	10
2a	An eccentric, compressive 1220 N force P is applied to the end of a cantilever beam. Replace P with an equivalent force-couple system at G.	 Fig. Q 2a	5
2b	A uniform steel plate 18 cm square weighing 50 N is suspended in the horizontal plane by the three vertical wires as shown. Calculate the tension in each wire.	 Fig. Q 2b	7

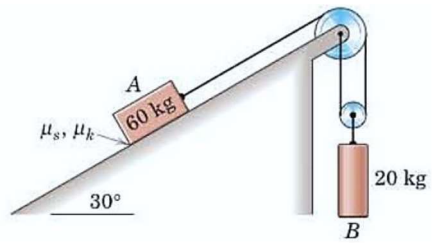
3	Block *A* weighing *1000 N* is to be raised by means of a 15^0 wedge *B* weighing *500 N*. Assuming the coefficient of friction between all the contact surface to be *0.2*, determine, what minimum horizontal force *P* should be applied to raise the block (Ref Fig. Q 3).	 Fig. Q 3	12

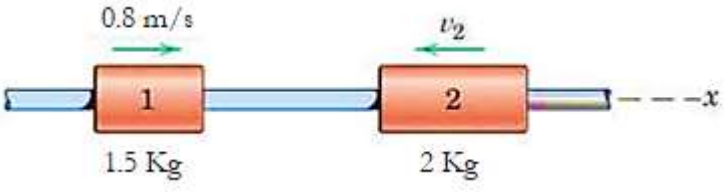
4	Find magnitude and nature of the force in the member *CF* of the plane truss loaded and supported as shown in Fig. Q 4.	 Fig. Q 4	12

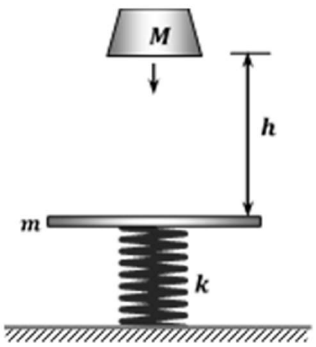
5	Determine the position of the centroid and area moment of inertia of the shaded area (Ref Fig. Q 5) with respect to x axis.	 Fig. Q 5	12

Group B — Answer any two out of four

Sl No.	Question	Marks
6a	The velocity v and displacement x of a particle moving along x-axis is correlated as $v = -kx^{3/2}$. Velocity of the particle at time t_0 was v_0 and the corresponding location was x_0. Express its velocity as a function of time only.	7
6b	Prove that the maximum range of a projectile on a horizontal plane is four times of its corresponding maximum height it attains.	5

7a	Define dynamic equilibrium and explain D'Alembert's Principle in this context.	4
7b	The system (Ref. Fig. Q 7b) is released from rest with the cable taut. For the friction coefficients, $\mu_s = 0.25$ and $\mu_k = 0.20$, calculate the acceleration of each body and the tension T in cable attached with 60 kg block. Neglect the small mass and friction of the pulleys.  Fig. Q 7b	8

8a	Define coefficient of restitution. How an impact is classified based on the coefficient of restitution ?	4
8b	Determine the final velocities v_1' and v_2'after the collision of the two cylinders (Ref Fig. Q 8b) if v_2 is 2.4 m/sec. The coefficient of restitution is e= 0.5 and the shaft is smooth. Also determine the percentage n of the original energy lost during the impact.  Fig. Q 8b	8

9	A flat plate of mass m is held at rest on a spring of stiffness k but of negligible mass as shown in Fig. Q 9. Now, a heavy block of mass M is released from a height h with respect to the plate. Neglect the energy loss due to air drag as well as in impact between the block and the plate. Also assume that the block always stays in contact with the plate after impact. i. Find the velocity of the block just before and after the impact. ii. Test whether the law of conservation of linear momentum is valid here or not. iii. Also find the maximum compression of the spring. iv. Explain with logic whether the spring mass system under the given circumstances finally attains a steady state or not.  Fig.-Q9	3+3+ 4+2=12