Indian Institute of Technology Guwahati

ME 101: Engineering Mechanics (2020-21, Sem II)

Quiz - II (15.05.2021)

Time: 10:30 AM – 12:00 Noon Full Marks: 60

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1. A basketball player does a dunk and applies a force of 900 N on the rim, as shown in **Figure 1**. The link EF is parallel to the member BCD.

(a) Determine the reaction forces and reaction moment at the support O. **[2 marks]**
(b) Identify the two force members in the figure. **[1 mark]**
(c) Determine the magnitude and the nature of the force in the member AB. **[5 marks]**
(d) Determine the component of forces acting at the location C on the member BCD. **[1 mark]**
(e) Draw the shear force and bending moment diagram from the location O to C along the axis of the member OE? **[6 marks]**

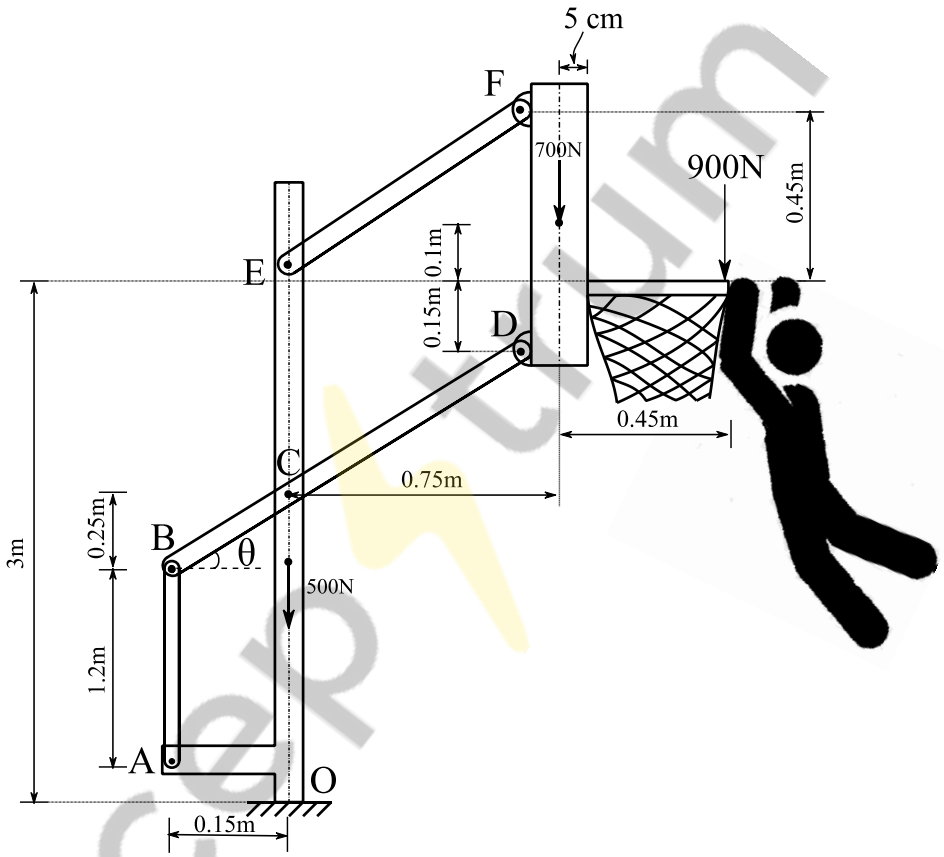

Figure 1

2. A brass cone having a base diameter of 40 cm and a height of 60 cm is placed on top of a vertical steel cylinder of the same diameter and a height of 40 cm. Determine the mass moment of inertia of the composite body about the vertical geometric axis. Take the density of brass as $8400\,\text{kg/m}^3$ and that of steel as $7850\,\text{kg/m}^3$. [**10 Marks**]

3. Determine the magnitude and location of the resultant hydrostatic force acting on the inclined submerged rectangular plate as shown in **Figure 2**. Given data: $Z_1 = 2$ m, $Z_2 = 5$ m, $L = 4$ m, $b = 2$ m and density of the liquid is $\rho = 1000$ kg/m^3. Take $g = 9.81$ m/s^2**.** **[2 + 3 = 5 marks]**

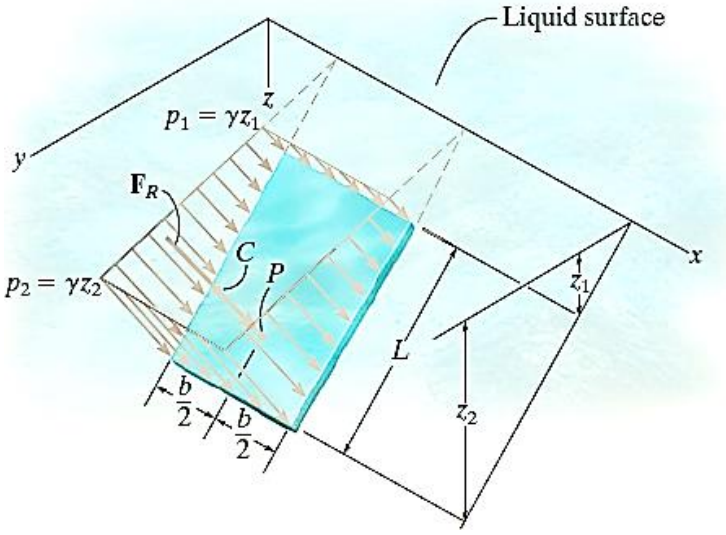

Figure 2

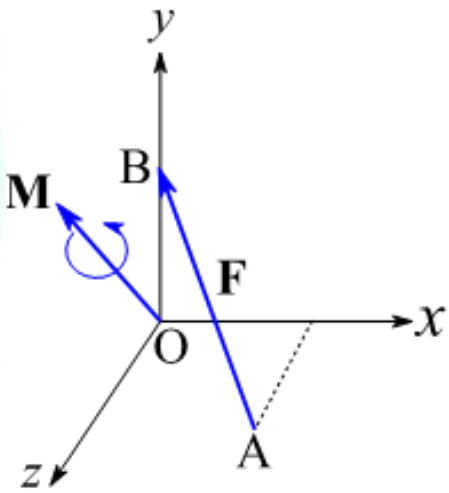

Figure 3

4. A system consists of a couple **M** = $72\hat{j} + 36\hat{k}$ (N-m) and a force F = 30 N as shown in **Figure 3**. Find the (x, y, z) coordinates in x-z plane at which the wrench is formed. The co-ordinates of **A** and **B** are **A (4 m, 0, 2 m)** and **B** (**0, 4 m, 0**) respectively. **[4 + 6 = 10 marks]**

5. (a) The variation of acceleration a of a particle with velocity V is given by $a = \frac{5}{V^2}$. Find the expression for velocity and displacement in terms of time assuming the body starts with initial velocity of 2 m/s and initial displacement of 3 m. Plot the variation of velocity with displacement and schematically show how you can determine acceleration graphically when time t = 5 sec. You may, **use Matlab/any other tool for plotting purpose.** **[2+2+2+2 Marks]**

(b) The robotic device rotates about a fixed vertical axis while its arm extends and elevates as shown in **Figure 4**. At a given instant $\phi = 45^0, \dot{\phi} = 20$ deg/s = constant,

d = 0.5 m, $\dot{d} = 0.2$ m/s, $\ddot{d} = -0.25$ m/s^2, Ω = 0 deg/s = constant .

If the arm is in x-y plane, determine the magnitude of the velocity and acceleration of the gripper P. Also, write the velocity and acceleration using the Cartesian coordinate system x, y. [**7 marks**]

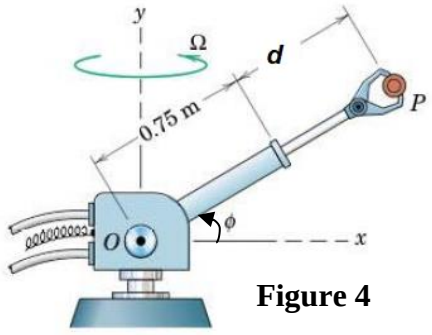

Figure 4

6. (a) Define virtual work principle. With the help of a schematic diagram, show stable, unstable and neutral equilibrium points and their relation with potential energy. [**3 Marks**]

(b) Using virtual work principle, determine Weight W (**Figure 5**), if the effort P = 250 N is required to hold the weight W in equilibrium in a system of two frictionless pulleys of the same diameter. [**2 Marks**]

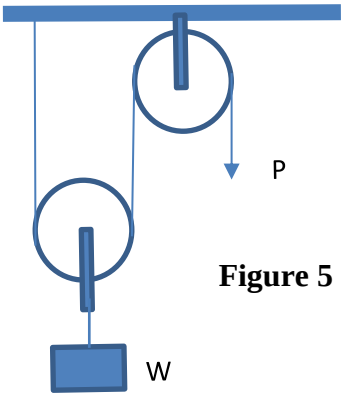

Figure 5