Ref. No.: EX/EE/AM/ME/T/1A/2018

B.E. ELECTRICAL ENGINEERING

FIRST YEAR FIRST SEMESTER EXAMINATION-2018

Subject: ENGINEERING MECHANICS **Time: Three Hours** **Full Marks: 100**

*Answer Any **FIVE** Questions.*

Marks are equally distributed among the parts of a question unless specified otherwise.

*Value of '**g**' (acceleration due to gravity) may be taken as **10 m/s²**, if it is not specified.*

Any missing data may be suitably assumed.

1. Answer the following questions-

   a. The turnbuckle shown in **Figure (1b)** is tightened until the tension in cable ***AB*** is **1.2 kN**. Calculate the magnitude of the moment about point ***O*** of the force acting on point ***A***. **[08]**

   b. The specialty tool (with members ***BDE***, ***CD***, ***EFG*** and ***ACFH***) as shown in **Figure (1b)** is used for installing and removing snap rings. Determine the spreading force applied at ***G*** and ***H*** if $P = 50$ N. **[12]**

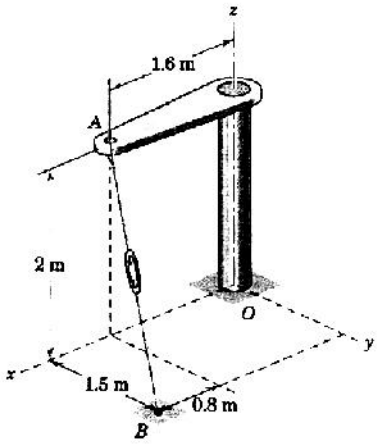

Figure (1a)

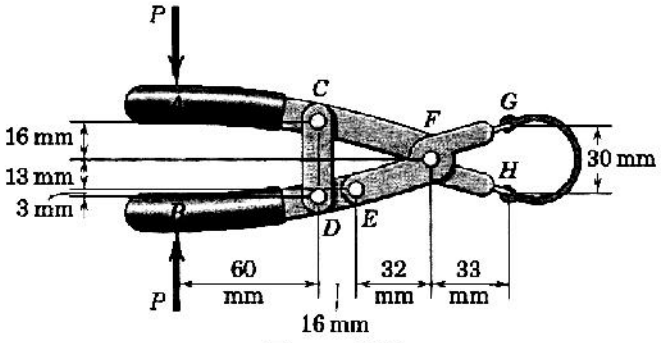

Figure (1b)

2. The large bracket shown in **Figure (2)** is constructed of heavy plate which has a uniform mass ρ per unit area. Determine the force and moment reactions at the support bolt at ***O***. The bolt joint can be treated as a fixed support. **[20]**

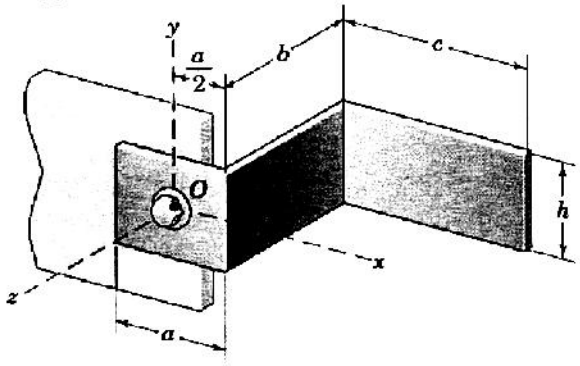

Figure (2)

[Turn over

3. Answer the following questions-

   a. The inverted track ***T*** with freely floating cylinder ***C*** comprise a system which is designed to hold paper or other thin materials ***P*** in place as shown in **Figure (3a)**. The coefficient of static friction is μ_s for all interfaces. What minimum value of μ_s ensures that the device will work no matter how heavy the supported material ***P*** is? Weight of the cylinder ***C*** can be considered negligible as compared to the weight of the material ***P*** which is supported by the friction forces on its both vertical surfaces. **[12]**

   b. Using Pappus' Theorem determine the surface area of revolution of the conical shell shown in **Figure (3b)**. **[8]**

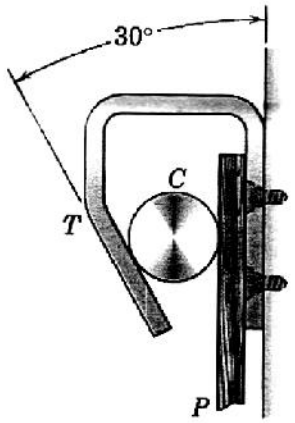

Figure (3a)

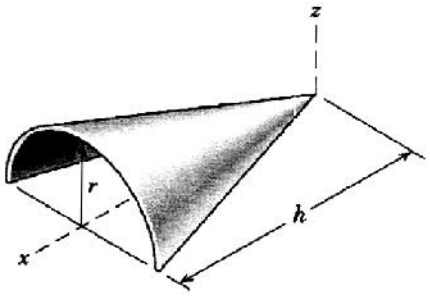

Figure (3b)

4. Answer the following questions-

   a. A rocket is released at point ***A*** from a jet aircraft flying horizontally at **1000 km/h** at an altitude of **800 m** as shown in **Figure (4a)**. If the rocket thrust imparts the rocket a constant horizontal acceleration of **0.5g** determine the angle θ from the horizontal to the line of sight of the target at the instant of release of the rocket. **[8]**

   b. The slotted arm ***OA*** drives the small pin ***P*** to move in the fixed spiral guide defined by $r = K\theta$ as shown in **Figure (4b)**. The arm ***OA*** starts from rest at $\theta = \pi/4$ and has a constant counterclockwise angular acceleration $\ddot{\theta} = \alpha$. Determine the magnitude of acceleration of pin ***P*** when $\theta = 3\pi/4$. **[12]**

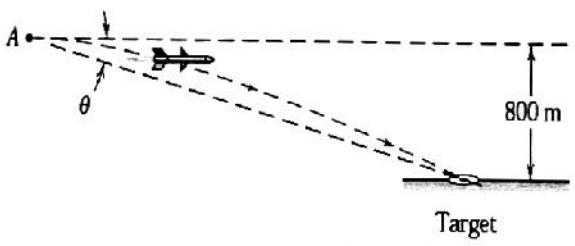

Figure (4a)

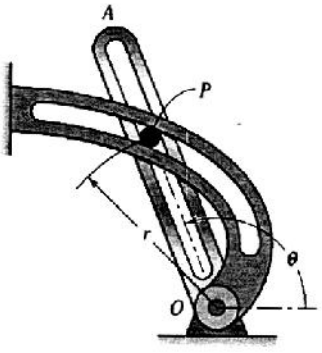

Figure (4b)

5. Answer the following questions-

a. The two blocks are kept on the inclined plane as shown in **Figure (5a)**. Neglecting the masses of the pulleys and the effect of friction in the pulleys and between the blocks and the incline, determine the acceleration of each block and the tension in the cable. **Draw the necessary free-body diagram(s).** **[10]**

b. A flatbed truck moving at a constant speed of **100 km/h** takes turn through a horizontal curve with radius of curvature ρ = **300 m** as shown in **Figure (5b)**. The road is inwardly banked at an angle of **10°**. The coefficient of static friction between the truck bed and the **200-kg** crate mounted on it is **0.70**. Calculate the friction force acting on the crate. Decide whether the crate will slide down the truck bed. **Draw the necessary free-body diagram(s).** **[10]**

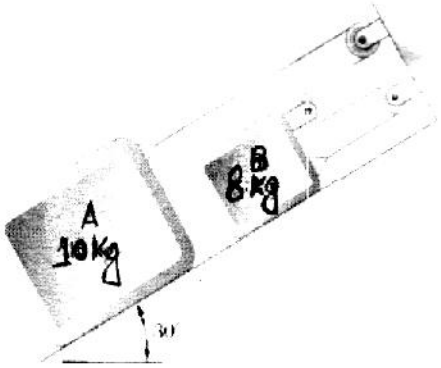

Figure (5a)

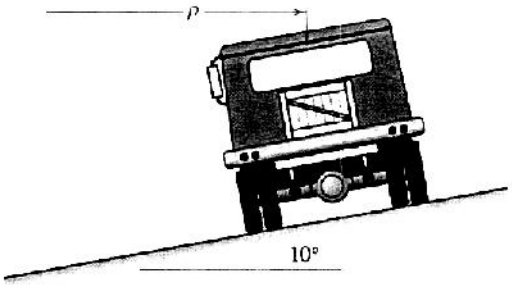

Figure (5b)

6. Answer the following questions-

a. The **10-kg** slider moves with a negligible friction up the inclined guide as shown in **Figure (6a)**. The attached spring has a stiffness of **60 N/m** and is stretched **0.6 m** in position ***A***, where the slider released from rest. The force of **250 N** applied at the end of the cord remains constant in magnitude and direction throughout the travel of slider from position ***A*** to ***C*** and the pulley offers negligible resistance to the motion of the cord. Calculate the speed of the slider as it passes the point ***C***. **[10]**

b. A pendulum consists of two **3.2-kg** concentrated masses on a light but rigid rod as shown in **Figure (6b)**. The pendulum is swinging through the vertical position with a clockwise angular velocity ω = **6 rad/s** when a **0.05-kg** bullet, travelling with velocity v = **300 m/s** in the direction shown strikes the lower mass and becomes embedded on it. Calculate the angular velocity of the pendulum immediately after the impact and find the maximum angular deflection of the pendulum from the vertical position. **[10]**

[Turn over

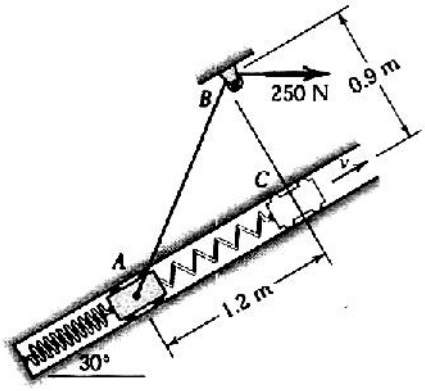

Figure (6a)

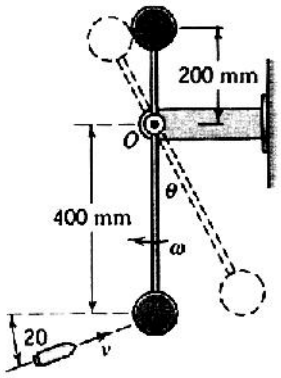

Figure (6b)

7. Write short notes with **mathematical derivation** on the following- **[20]**
   a. **Parallel axis theorem in relation to area moment of inertia.**
   b. Equivalent force system.
   c. Work done under conservative force.
   d. Radial and transverse components of acceleration of a particle.