B.E. MECHANICAL ENGINEERING SECOND YEAR FIRST SEMESTER EXAM 2025

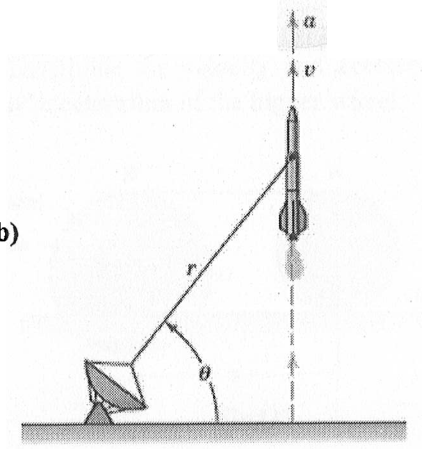
ENGINEERING DYNAMICS

Answer Any Five (5) Questions. Assume $g = 9.81$ m/s², whenever required. Parts of the same question are to be answered together. Irrelevant answers will attract penalty.

Q1(a) Prove the formula for **acceleration** of a particle **in polar co-ordinates.**

Q1(b) The vertically-fired rocket and tracking radar is shown in **Fig Q1(b)**. At the instant when $\theta = 60^0$, measurements give $\dot{\theta} = 0.03\ rad/s$ and r = **7500 m**, and the vertical acceleration of the rocket is found to be a = **20 m/s²** . For this instant determine the values of $\ddot{r}$ and $\ddot{\theta}$.

Fig Q1(b)



Q2(a). Fig Q2(a) shows a cylinder of mass m resting in a supporting carriage. If $\beta = 45^0$ and $\theta = 30^0$, calculate the **maximum acceleration** a_{max} which the carriage may be given **up the incline** so that the cylinder **does not loose contact** at **B.** Further **'contact loss at B, requires an upward acceleration'**. Justify this statement without solving the problem.

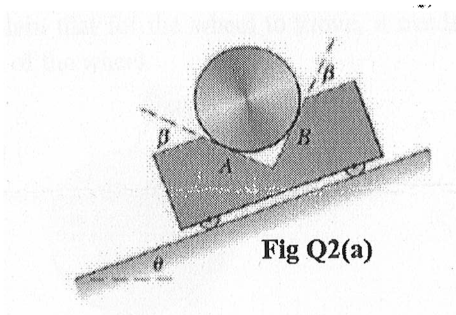


Fig Q2(a)

Q2(b) Refer **Fig Q2(b)**. The **1500 kg** car is travelling at **100 km/h** on the straight portion of the road, and then its speed is reduced **uniformly** from **A** to **C**, at which point it comes to **rest**. Compute the magnitude

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of the **total friction force** exerted by the road on the car (a) just before it passes point **B** (b) just after it passes point **B** and (c) just before it stops at point **C**.

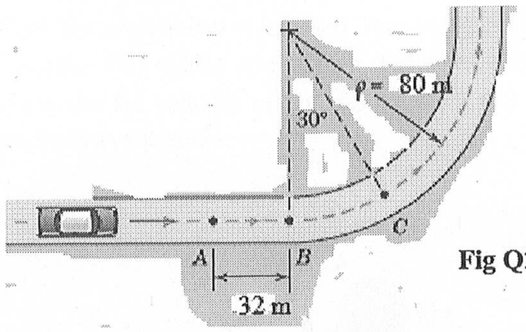

Fig Q2(b)

Q3 Fig Q3 shows two connected wheels. The centre **C** of the smaller wheel has a velocity of **0.4 m/s** and an acceleration of **0.8 m/s²**. Determine the **velocity** and **acceleration** of points **A, B, O** and **angular velocity** and **angular acceleration** of the **bigger wheel**.

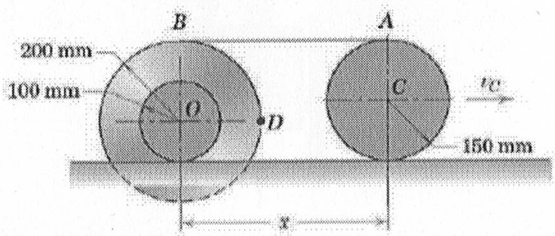

Fig Q3

Q4 Refer **Fig Q4**. The wheel and its hub have a **mass of 30 kg** with a **centroidal radius of gyration of 450 mm**. A cord wrapped securely around its hub is attached to the fixed support, and the wheel is released from rest on the incline. The **coefficients of static and kinetic friction** between the wheel and the incline are **0.4** and **0.3** respectively. Show that **the wheel cannot remain at rest**. Then explain that for the wheel to move, it needs to **slip**. Hence calculate the **acceleration** of the **centre** of the wheel.

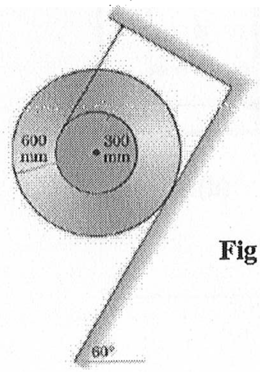

Fig Q4

5 Prove **the angular momentum principle in relative form for a system of particles**. Hence obtain the equation for plane motion of a rigid body and state the points about which it holds.

6(a) Refer **Fig Q6(a)**. When the mechanism is released from **rest** in the position where $\boldsymbol{\theta} = \mathbf{60^0}$, the **4 kg** carriage drops and the **6 kg** sphere rises. Show that when $\boldsymbol{\theta} = \mathbf{180^0}$, the **carriage** has **zero velocity**. Hence, determine the **velocity** of the **sphere** when $\boldsymbol{\theta} = \mathbf{180^0}$. Neglect the mass of the links and treat the sphere as a particle.

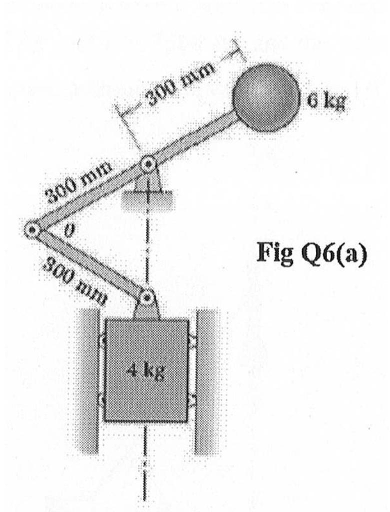

Fig Q6(a)

6(b) A uniform **square plate** of mass M is supported at **frictionless** bearing at O and is able to swing, when required, about a **horizontal** axis through **O** as shown in **Fig Q6(b)**. Suddenly the supporting wire at **A** snaps out. Determine the angular velocity of the plate when the corner **C** is directly below point **O**.

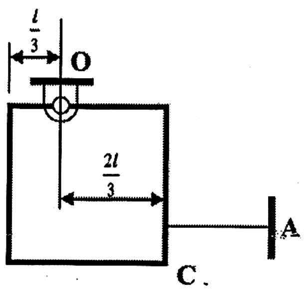

Fig Q6(b)