Ref. No.: EX/ET/AM/ME/T/1B/125/2019 (Old)

B.E. ELECTRONICS AND TELE-COMMUNICATION ENGINEERING

FIRST YEAR 2ND SEMESTER EXAM 2019 (Old)

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

Value of 'g' (acceleration due to gravity) may be taken as 10 m/s^2, if it is not specified.

Any missing data may be suitably assumed with proper justification.

Group A ***(Answer any two questions from this group)***

Q1a. Replace the three forces acting on the bent pipe, as shown in **Fig. Q1a**, by an equivalent force-couple system at the point "***O***". Find the distance x from the point "***O***" to the point on x-axis through which the line of action single resultant force (with zero moment), equivalent to the given force system, will pass. **[10]**

Q1b. Find out the moment of the **1.2 kN** force, as shown in **Fig. Q1b**, about the axis "***O-O***". **[10]**

Q1c. The motor mounted on the bracket is acted on by its own weight of **160 N**, as shown in **Fig. Q1c**. In addition to this its shaft resists the **120-N** thrust and a **25-N·m** couple applied to it. Determine the resultant of this force system in terms of a force R at the point "A" and the associated couple moment M. Express R and M as vectors. **[10]**

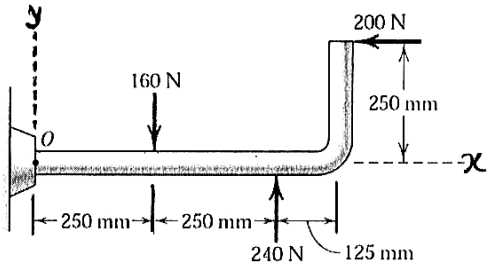


Fig. Q1a

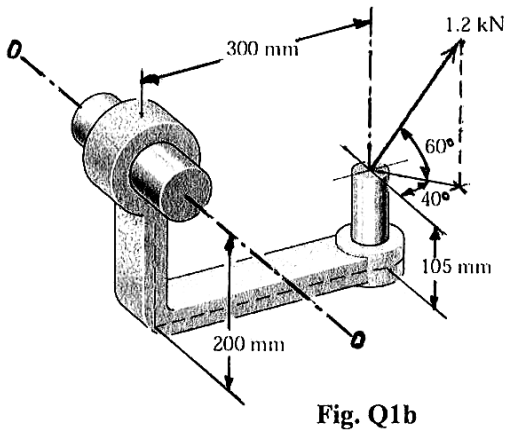


Fig. Q1b

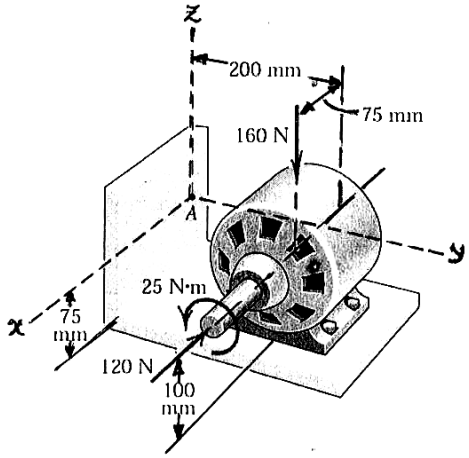


Fig. Q1c

Group B (*Answer any two questions from this group*)

Q2a. Determine the tensions in the three cables which support the uniform **80-kg** plate, whose shape is that of an equilateral triangle, as shown in **Fig. Q2a**. The mass centre "***G***" of the plate is located one-third of the distance ***MC*** from "***M***". **Draw the necessary free body diagram(s).** **[10]**

Q2b. For the frame shown in **Fig. Q2b**, determine the reaction force at the roller "***F***" and the force transmitted by the link "***BD***". **Draw the necessary free body diagram(s).** **[10]**

Q2c. The circular cylinder weighs **30 kg** and is held by a cord fixed to its periphery at "***B***" and to the ground at "***A***" as shown in **Fig. Q2c**. If the coefficient of static friction between the ground and the cylinder is **0.60**, calculate the force ***P*** required to bring the cylinder on the verge of slipping. Consider that there is no friction between the cylinder and the cord. **Draw the necessary free body diagram(s).** **[10]**

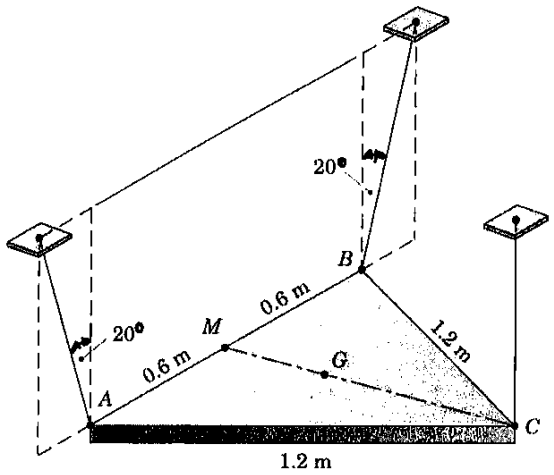


Fig. Q2a

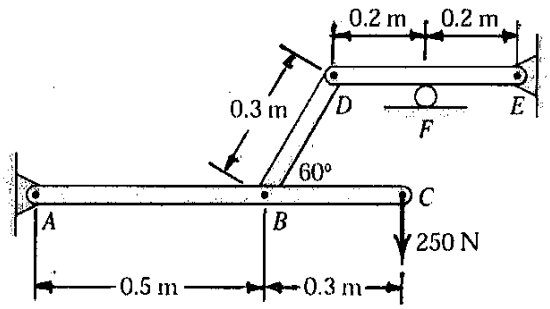
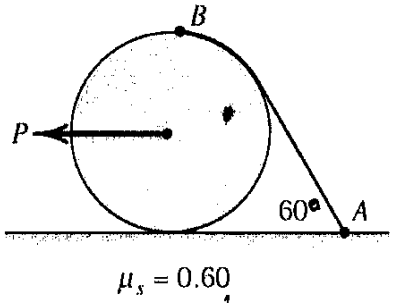


Fig. Q2b



$\mu_s = 0.60$

Fig. Q2c

Group C (*Answer any two questions from this group*)

Q3a. Find the x- and y-coordinate of the centroid of the shaded area shown in the **Fig. Q3a.** **[10]**

Q3b. Using Pappus Theorem determine the volume V and the total surface area A of the solid as shown in **Fig. Q3b.** **[10]**

Q3c. Find out the 2nd moment of the shaded area about x-axis as shown in **Fig. Q3c.** Consider $a = b = 200$ **mm.** **[10]**

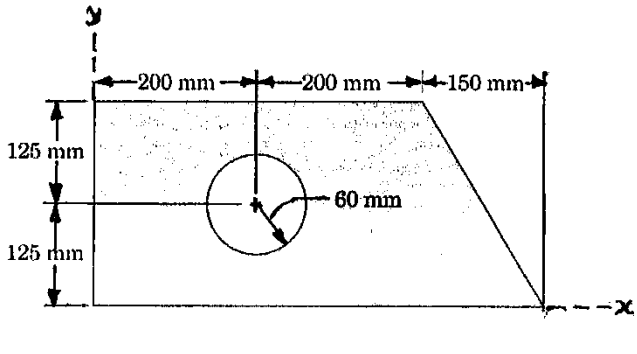


Fig. Q3a

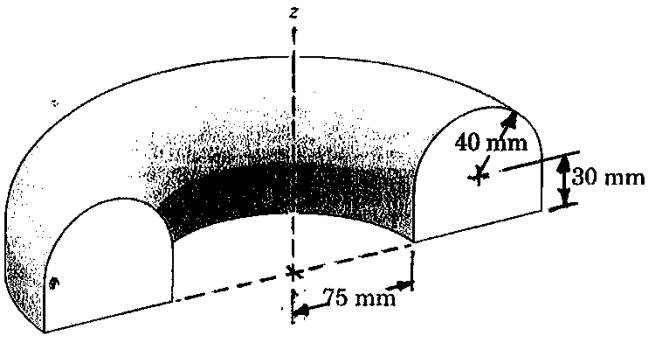


Fig. Q3b

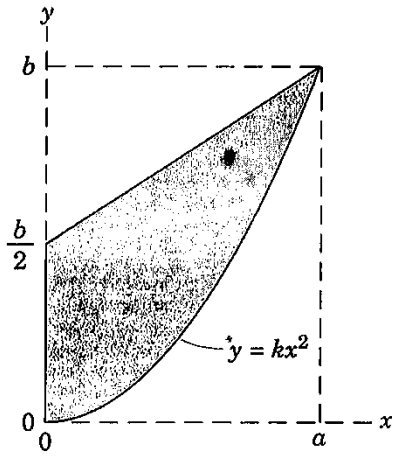


Fig. Q3c

Group D (*Answer any two questions from this group*)

Q4a. The muzzle velocity of a long-range rifle (as shown in **Fig. Q4a**) at "*A*" is u = **400 m/s**. Determine the two possible angles of elevation θ_1 and θ_2, either of which will permit the projectile to hit the mountain target "*B*". **[10]**

Q4b. The race car "*A*" follows path *a-a* while the race car "*B*" follows path *b-b* on the unbanked track as shown in **Fig. Q4b**. If each car has a constant speed limited to that corresponding to a normal acceleration of **8 m/s^2**, determine the intervals of time t_A and t_B for both cars respectively, to negotiate a turn as delimited by the line *C-C*. **[10]**

Q4c. For the system shown in **Fig. Q4c**, the cylinder "*B*" has a downward velocity given by $v_B = t^2/2 + t^3/6$ **m/s**, where t is expressed in second. Calculate the acceleration of "*A*" when t = **2 s**. **[10]**

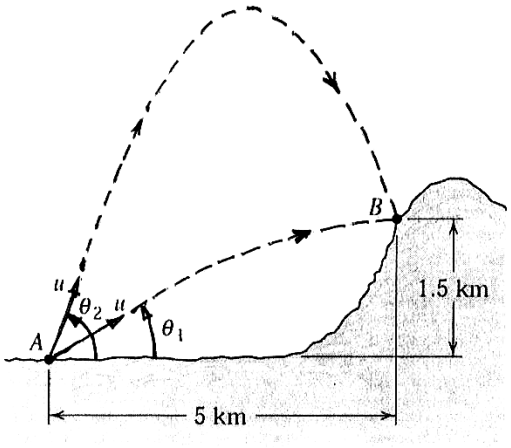


Fig. Q4a

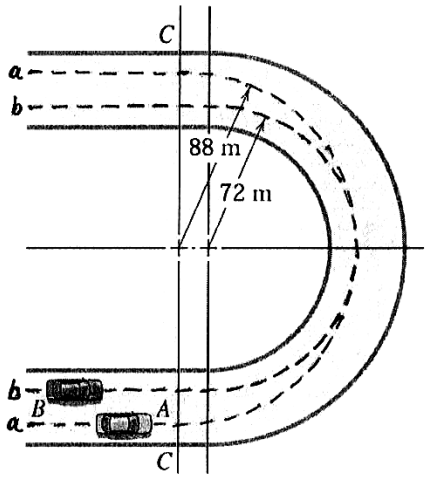


Fig. Q4b

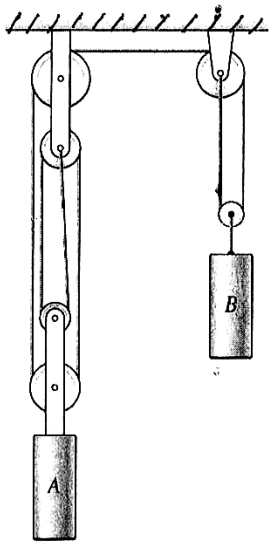


Fig. Q4c

Group E (*Answer any two questions from this group*)

Q5a. In the system shown in **Fig. Q5a**, at the instant of time when $\theta = 30°$, the horizontal guide is given a constant upward velocity $v_0 = 2$ **m/s**. For this instant calculate the force N exerted by the fixed semi-circular slot and the force P exerted by the horizontal slot on the **0.5-kg** pin "*A*". The width of the slots is slightly greater than the diameter of the pin, and the friction is negligible. **Draw the necessary free body diagram(s).** **[10]**

Q5b. The **2-kg** collar is released from rest at "*A*" and slides down the fixed inclined rod in the vertical plane as shown in **Fig. Q5b**. The coefficient of kinetic friction between the collar and the rod is **0.40**. Calculate the velocity v of the collar as it strikes the spring and the subsequent maximum deflection x of the spring. **[10]**

Q5c. The **4-kg** cart, at rest when $t = 0$, as shown in **Fig. Q5c**, is acted on by a horizontal force which varies with time t as shown. Neglect the friction and determine the velocity of the cart at $t = 1$ **s** and at $t = 3$ **s**. **Draw the necessary free-body diagram(s).** **[10]**

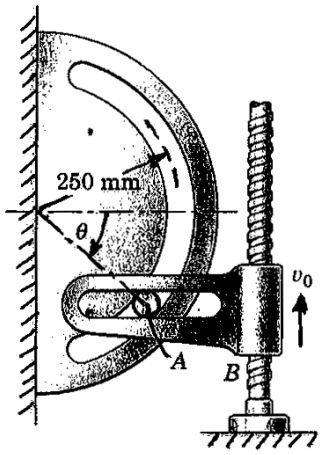


Fig. Q5a

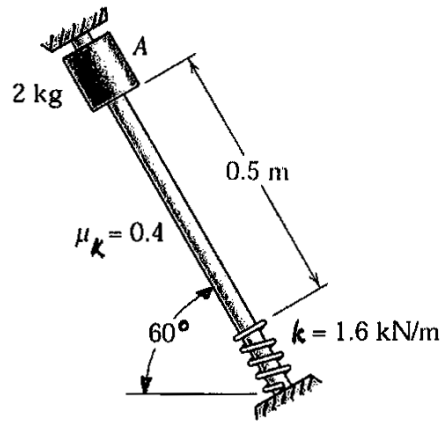
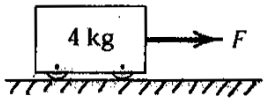


Fig. Q5b



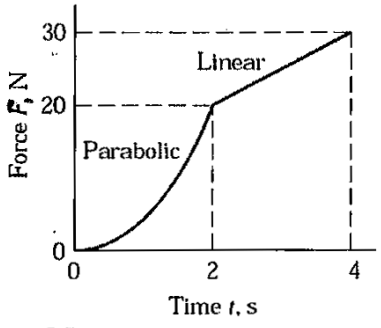


Fig. Q5c