UNIVERSITY COLLEGE TATI

UNIVERSITY COLLEGE TATI (UC TATI)

FINAL EXAMINATION QUESTION BOOKLET	
COURSE CODE	: BMT 2122
COURSE	: DYNAMIC AND MECHANISM
SEMESTER/SESSION	: 2-2024/2025
DURATION	: 2 HOURS

Instructions:

1. This booklet contains 4 questions. Answer **ALL** questions.
2. All answers should be written in answer booklet.
3. Write legibly and draw sketches wherever required.
4. If in doubt, raise your hands and ask the invigilator.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO

THIS BOOKLET CONTAINS 6 PRINTED PAGES INCLUDING COVER PAGE

QUESTION 1

a) The motion of a particle is defined by the relation $\mathbf{x = t^3 - 6t^2 - 36t - 40}$, where x and t are expressed in meters and seconds, respectively. **Find**

i. time when the velocity is zero (2 marks)

ii. the velocity, the acceleration and total distance traveled when $\boldsymbol{x = 0}$ (3 marks)

b) A truck travels 220 m in 10 s while being decelerated at a constant rate of 0.6 m/s^2. **Compute**

i. its initial velocity (3 marks)

ii. its final velocity (3 marks)

iii. the distance traveled during the first 1.5 s (4 marks)

c) A ball is thrown from A. If it is required to clear the wall at B, **determine** the minimum magnitude of its initial velocity V_A in Figure 1. (10 marks)

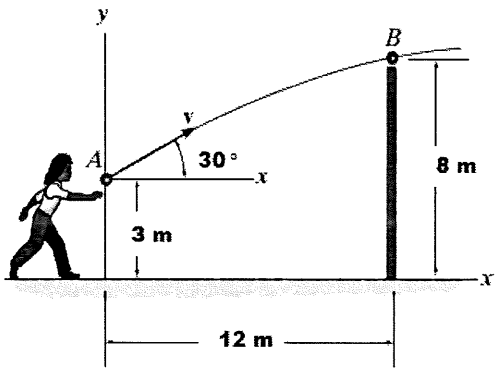

Figure 1

QUESTION 2

a) The coefficient of friction between the load and the flat-bed trailer shown in Figure 2 are μ_s = 0425 and μ_k = 0.30. Knowing that the speed of the rig is 72 km/h, **find** the shortest distance in which the rig can be brought to a stop if the load is not to shift.

(5 marks)

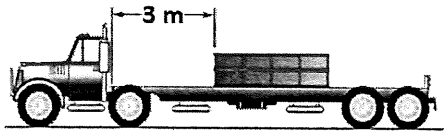

Figure 2

b) The coefficient of kinetic energy between the 20-kg block and the inclined plane is μ_k = 0.2, if the block is traveling up the inclined plane with a constant velocity v = 5 m/s shown in Figure 3, **solve** the power of force F. (10 marks)

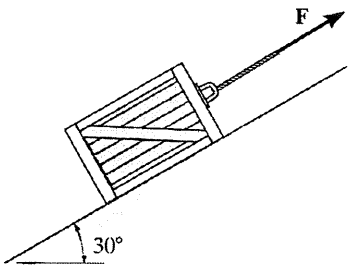

Figure 3

c) Blocks A and B shown in Figure 4 have a mass of 3 kg and 5 kg, respectively. If the system is released from rest, **determine** the velocity of block B in 6 s. Please use principle of momentum. (10 marks)

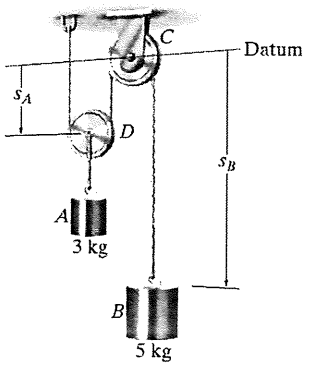

Figure 4

QUESTION 3

a) A particle travels along a straight line with a speed $\boldsymbol{v = (4t - 3t^2)}$ m/s, where t is in seconds. **Compute** the position of the particle when t = 4 s (5 marks)

b) The angular acceleration of the disk is defined by $\alpha = 3t^2 + 12$ rad/s, where t is in seconds. If the disk is originally rotating at ω_0= 12 rad/s in Figure 5, **solve**

i. the velocity (3 marks)

ii. the normal,n and tangential,t components of acceleration of point A on the disk when t = 2 s (7 marks)

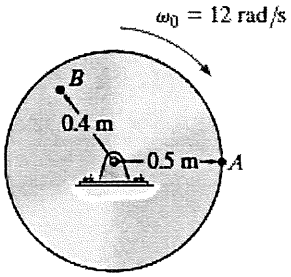

Figure 5

c) If crank OA rotates with an angular velocity of $\omega = 12\ rad/s$, **determine** the velocity of piston B and the angular velocity of rod AB at the instant shown in Figure 6.

(10 marks)

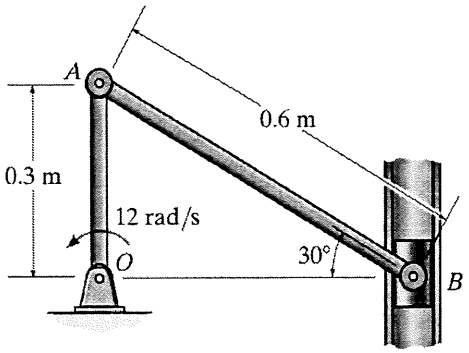

Figure 6

QUESTION 4

a) A uniform 50 kg crate rests on a horizontal surface for which the coefficient of kinetic friction is μ_k = 0.2. **Determine** the acceleration if a force of P= 600 N is applied to the crate as shown in Figure 7. (10 marks)

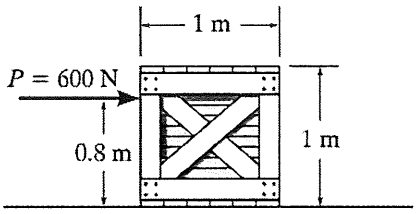

Figure 7

b) The 80 kg wheel has a radius of gyration about its mass center of O of $k_o = 400\ mm$ shown in Figure 8. **Determine** its angular velocity after it has rotated 20 revolutions starting from rest. (15 marks)

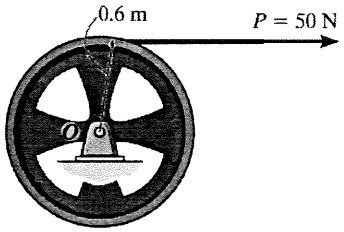

Figure 8

----------End of question----------

FORMULA

Newton's 2nd Law:

$$\sum F = ma$$

Equation of Linear Motion:

$$v = v_O + a_C t$$

$$s = s_O + v_O t + \tfrac{1}{2} a_C t^2$$

$$v^2 = v_O{}^2 + 2a_C (s - s_O)$$

Kinetics of Particle:

Newton's Second Law:

$$\Sigma F_x = ma_x$$

$$\Sigma F_y = ma_y$$

Principle of Work and Energy:

$$\Sigma T_1 + \Sigma U_{1-2} = \Sigma T_2$$

Work of Friction Caused by Sliding.

$$\tfrac{1}{2}mv^2 + Ps - \mu_k Ns = \tfrac{1}{2}mv^2$$

Power and Efficiency

$$P = \mathbf{F} \cdot \mathbf{v}$$

$$\epsilon = \frac{\text{power output}}{\text{power input}}$$

Principle of Impulse and Momentum:

$$m\mathbf{v}_1 + \Sigma \int_{t_1}^{t_2} \mathbf{F}\, dt = m\mathbf{v}_2$$

Friction:

$$F = \mu_k N$$

Circular Motion:

$$\theta = rad$$

$$\omega = \frac{d\theta}{dt}, rad/s$$

$$\alpha = \frac{d\omega}{dt}, rad/s2$$

Acceleration constant:

$$\omega = \omega_0 + \alpha_c t$$

$$\theta = \theta_0 + \omega_0 t + \tfrac{1}{2}\alpha_c t^2$$

$$\omega^2 = \omega_0^2 + 2\alpha_c(\theta - \theta_0)$$

Motion at Point P:

$$v = \omega r$$

$$a_t = \alpha r$$

$$a_n = \omega^2 r$$

Relative Motion Analysis: Velocity

$$\mathbf{v}_B = \mathbf{v}_A + \mathbf{v}_{B/A}$$

$$\mathbf{v}_B = \mathbf{v}_A + \boldsymbol{\omega} \times \mathbf{r}_{B/A}$$

Kinetic of Rigid Body: Force and Acceleration

Equations of Motion: Translation

$$\Sigma F_n = m(a_G)_n$$

$$\Sigma F_t = m(a_G)_t$$

$$\Sigma M_G = 0$$

Work and Energy

$$I_O = mk_O^2$$

$$T_2 = \tfrac{1}{2} I_O \omega^2$$

$$s = \theta r$$