Mid-Semester Test (30% CA)

Name : ______________________________ Adm No : _______________

Class : ________________________ Class S/N : ______________

Date : ________________________ Time allowed : 1.5 hour

Instructions

Answer all 7 questions. Take g = 9.80 m/s^2

This question paper consists of 3 printed pages including 1 page of formulas.

You are reminded that cheating during test is a serious offence.

All working in support of your answer must be shown.

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1. (a) Calculate the following to the appropriate significant figures :

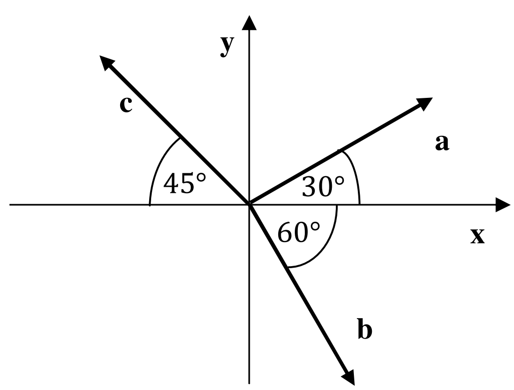
   (i) $(7.899 \times 1.90 \times 9.7878)$

   (ii) $\left(\dfrac{78.35}{214.9} + 56.134 - 8.94550\right)$

   (b) The damping ratio (D) is given by $D = \dfrac{c}{2\sqrt{km}}$, where c is the damping coefficient (SI unit of 'c' is N s/m), k is the spring constant (SI unit of 'k' is N/m)and m is mass. Show that the damping ratio is dimensionless.

(15 marks)

2. The magnitude of vectors **a**, **b**, and **c** in the below figure are all equal to 1. Find the direction of the vector **R** = **a** + **b** – **c**.



(10 marks)

3. A particle of mass 100 g moves in a circle of radius 20 cm. Its linear speed is given by $v = 2t$ where t is measured in seconds and v in m/s. At time $t = 3$s, find the magnitude of
   (i) centripetal acceleration.
   (ii) centripetal force on the particle.
   (iii) tangential acceleration.

(15 marks)

4. A ball is dropped from the top of a 50.0 m high cliff. At the same time a carefully aimed stone is launched vertically upwards from the bottom of the cliff with a speed of 24.0 m/s. The ball and stone collide.
   (i) When does the collision take place?
   (ii) How far above the base of the cliff does the collision take place?

(15 marks)

5. A ball is thrown at an angle of 30^o above the horizon with a speed of 20 m/s at a vertical wall. The base of the wall is 30 m away from where the ball was thrown. Find the (i) time taken for the ball to hit the wall.
   (ii) position of the point of contact when the ball hit the wall.
   (iii) magnitude and direction of the velocity vector when the ball hits the wall.

(15 marks)

6. A 3.0-kg object is under the influence of two forces which are $\mathbf{F_1} = (16\,\mathbf{i} + 12\,\mathbf{j})$N and $\mathbf{F_2} = (-10\,\mathbf{i} + 22\,\mathbf{j})$ N. If the object is initially at rest, what is the
   (i) net force vector acting on the object?
   (ii) acceleration vector at $t = 3.0$ s ?
   (iii) velocity vector at $t = 3.0$ s?

(15 marks)

7. As shown in the below figures the masses attached to a pulley (you can assume the mass of the pulley and the string are negligible and the string is inextensible). When $M_1 = M$, the tension in the string is T_o (see Figure 1). However, when $M_1 = 0.8$ M, the masses accelerate and the tension decreases by 0.300 N (see Figure 2). Find the acceleration a and mass M. (15 marks)

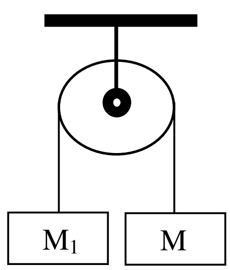


Figure 1

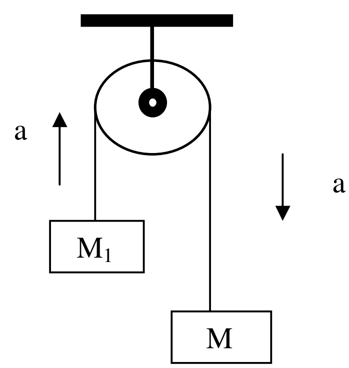


Figure 2

****************END of Paper****************

Formula sheet for MS811M

Name: ________________________ Admin. No.: _______________ Seat No.: ________

Kinematics

$$v_x = v_{0x} + a_x t$$
$$v_x^{\,2} = v_{0x}^{\,2} + 2a_x(x - x_0)$$
$$x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$$
$$\vec{v} = \frac{d\vec{r}}{dt}, \quad \vec{a} = \frac{d\vec{v}}{dt}$$
$$y = (\tan\theta)x - \left(\frac{g}{2v^2\cos^2\theta}\right)x^2$$
$$R = \frac{v^2 \sin 2\theta}{g}$$

Dynamics

$$\vec{F} = m\frac{d\vec{v}}{dt} = m\vec{a}, \; F = \mu N$$
$$a = \frac{dv}{dt}, \; a = \frac{v^2}{r}, \; F = m\frac{v^2}{r}$$
$$\vec{J} = \int \vec{F}dt = \Delta\vec{p}$$
$$W = \int \vec{F}.\vec{dr}, \; W_{net} = K_f - K_i$$
$$KE = \frac{1}{2}mv^2, \; PE = mgh$$
$$P = \frac{W}{t}, \quad P = \frac{dW}{dt}$$

Linear momentum

$$\vec{p} = m\vec{v}$$
$$m_1\vec{u}_1 + m_2\vec{u}_2 = m_1\vec{v}_1 + m_2\vec{v}_2$$

Static electricity

$$F = k\frac{q_1 q_2}{r^2}, \; k = \frac{1}{4\pi\varepsilon_o}$$
$$F = qE$$
$$V = k\frac{q}{r}, \; U = qV$$
$$\Phi_E = \oint \vec{E}.d\vec{A} = \frac{q}{\varepsilon_o}$$
$$V = Ed, \; W = qV, \; E = \frac{kq}{r^2}$$

Current electricity

$$Q = It \qquad V = IR$$
$$P = VI = I^2R = \frac{V^2}{R}$$

Magnetism & electromagnetism

$$\vec{F} = q\vec{v} \times \vec{B} \qquad \vec{F} = i\vec{L} \times \vec{B}$$
$$e.m.f. = -N\frac{d\Phi_B}{dt}$$
$$\Phi_B = BA$$

Thermodynamics

$$\Delta U = Q - W$$
$$W = \int p\,dV$$
$Q_V = nC_V\Delta T$ const vol

$Q_p = nC_p\Delta T$ const pressure

$$Q = mC\Delta T$$
$$Q = mL$$

Ideal Gas

$$pV = nRT$$
$pV^\gamma = c$ (adiabatic)

$$\gamma = \frac{C_p}{C_V}, \; C_p - C_v = R$$
$$W = pV\ln\frac{V_2}{V_1} = nRT\ln\frac{V_2}{V_1}$$
$$W = \frac{1}{\gamma - 1}(p_1V_1 - p_2V_2)$$

Rotational Motion

$$\omega = \frac{d\theta}{dt}, \quad \alpha = \frac{d\omega}{dt}$$
$$\omega = \omega_0 + \alpha t$$
$$\omega^2 = \omega_0^{\,2} + 2\alpha(\theta - \theta_0)$$
$$\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$$
$$I = \sum_i^n m_i r_i^2, \; I = \int r^2 dm, \; K = \frac{1}{2}I\omega^2$$

SHM & waves

$$T = \frac{1}{f} \quad v = f\lambda \quad \omega = 2\pi f$$
$$\omega = \frac{2\pi}{T} \quad k = \frac{2\pi}{\lambda}$$
$$\omega = \sqrt{k/m} \quad \omega = \sqrt{g/L}$$
$$x = A\cos(\omega t + \phi)$$
$$x = A\sin(\omega t + \phi)$$
$$y(x,t) = A\cos(\omega t \pm kx)$$
$$y(x,t) = A\sin(\omega t \pm kx)$$
$$\frac{\partial^2 y}{\partial x^2} = \frac{1}{v^2}\frac{\partial^2 y}{\partial t^2}$$

Circuits

$R = R_1 + R_2 + R_3 + \ldots$ series

$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$ parallel

$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \ldots$ series

$C = C_1 + C_2 + C_3 + \ldots$ parallel

$$Q = CV \qquad U = \frac{1}{2}CV^2$$

Constants

Charge on electron
$e = -1.60 \times 10^{-19}$ C

Coulomb's constant
$k = 9 \times 10^9$ N m^2 C^{-2}

Ideal gas constant
$R = 8.314$ J mol^{-1} K^{-1}

Mass of proton
$m_p = 1.67 \times 10^{-27}$ kg

Mass of electron
$m_e = 9.11 \times 10^{-31}$ kg

Permeability of free space
$\mu_o = 4\pi \times 10^{-7}$ N A^{-2}

Permittivity of free space
$\varepsilon_o = 8.85 \times 10^{-12}$ C^2 N^{-1} m^{-2}

Speed of light in vacuum
$c = 3.00 \times 10^8$ m s^{-1}