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CENTRE FOR SANDWICH PROGRAMMES

DEPARTMENT OF MATHEMATICAL SCIENCES.

B.Sc. DEGREE EXAMINATIONS IN MATHEMATICS

MAT 104: ELEMENTARY MATHEMATICS III

2011/2011

MAT104

INSTRUCTION: ANSWER ANY FOUR QUESTIONS

TIME ALLOWED: 2 HOURS

1. (a) Classify each of the following physical quantities as vector or scalar:

Velocity, acceleration, speed, momentum, force, work, displacement, magnetic moment, kinetic energy, temperature.

- (b) If  $A = 4i + 6j + 2k$  and  $B = i + 6j + k$ , find the magnitudes and direction cosines of  $(A + B)$  and  $(A - B)$

2. (a) For what values of  $m$  are the vectors  $A = mi - 2j + k$  and  $B = 2mi + mj - 4k$  perpendicular?

- (b) If  $A \times R = B + \lambda A$  and  $A \cdot R = 3$ , where

$A = 2i + j - k$ ,  $B = -i - 2j + k$ , and  $\lambda$  is a constant then find  $R$  and  $\lambda$

3. (a) The position vector of a particle at time  $t$  is given by  $r = 3\cos 2t i + 5\sin 2t j$ . Find the velocity and acceleration vectors of the particle when  $t = \frac{\pi}{4}$  and show that the angle between them at this time is  $\frac{\pi}{2}$ .

- (b) A particle, acted upon by constant forces  $6i + j - 3k$  and  $3i + j - k$  is displaced from the point  $i + 2j + 3k$  to the point  $5i + 4j + k$ . Find the total work done by the forces.

4. (a) Show that  $\nabla \cdot \nabla \phi = \nabla^2 \phi$  where  $\nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$ . Hence evaluate  $\nabla^2$  if  $\phi = 2x^3y^2z^4$

- (b) Show that the vector  $v = 3y^4z^2i + 4x^3z^2j - 3x^2y^2k$  is solenoidal.

5. (a) Show that for any three arbitrary vectors,  $A$ ,  $B$  and  $C$ .

$$(i) A \cdot (B \times C) = B \cdot (C \times A) = C \cdot (A \times B)$$

- (b) If  $r = \cos \omega t i + \sin \omega t j$ , show that

$$(i) r \cdot \frac{dr}{dt} = 0 \quad - \sin \omega t i + \cos \omega t j \cdot (-\omega \sin \omega t i + \omega \cos \omega t j)$$

$$(ii) \frac{d^2r}{dt^2} = -\omega^2 r \quad - \sin \omega t i - \cos \omega t j = -\omega^2 (\cos \omega t i + \sin \omega t j)$$

6. (a) Find the equation of the straight line which passes through the point  $(-2, 3)$  and is parallel to the line  $7x - y - 6 = 0$ .

- (b) Find the radius and coordinates of the centre of the circle  $x^2 + y^2 + 5x - 6y = 5$ .

- (c) Find the coordinates of the point where the line  $x + 2y = c$  meets the parabola  $y^2 = 10x$ , and find the value of  $c$  when this line is tangent to the parabola.

if  $A$  by 2  
if  $B$  by 3

$$A \cdot (B \times C) = B \cdot (C \times A) = C \cdot (A \times B)$$

Integration  
Result