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SET A

UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
JANUARY 2014 SESSION

SUBJECT CODE	:	FKB 10103/ FKB 14102
SUBJECT TITLE	:	ENGINEERING TECHNOLOGY MATHEMATICS 1
LEVEL	:	BACHELOR
TIME / DURATION	:	(3 HOURS) **9.00 am - 12.00 noon**
DATE	:	27 MAY 2014

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. Please write your answers on the answer booklet provided.
4. Answer should be written in blue or black ink except for sketching, graphic and illustration.
5. This question paper consists of ONE (1) section only. Choose and answer 5 out of 6 questions.
6. Answer all questions in English.
7. Standard Transformation Table is appended.

THERE ARE 5 PAGES OF QUESTIONS EXCLUDING APPENDIX 1 AND THIS PAGE.

(Total: 100 marks)

INSTRUCTION: There are six questions. ANSWER FIVE (5) questions only.

Please use the answer booklet provided.

Question 1

1. (a) The forces F_1 , F_2 , F_3 in newtons, in a framework in equilibrium are related by the following equations:

$$3F_1 - 2F_2 \cos 60^\circ + 2F_3 = 12$$
$$4F_1 \sin 30^\circ - 2F_2 - F_3 = -2\cos 60^\circ$$
$$2F_1 \cos 60^\circ + 2F_2 + 6F_3 \sin 30^\circ = 12$$

Determine the value of the force F_1 only .

(10 marks)

(b) Consider a linear system $\begin{aligned} kx + 3y &= -6 \\ x + (k+2)y &= 2 \end{aligned}$.

Write the system in augmented matrix form and reduce it by elementary row operations to the echelon form , $\left[\begin{array}{cc|c} k & 3 & -6 \\ 0 & * & * \end{array}\right]$

For what values of k does the system

i) have a unique solution ?

(6 marks)

ii) have infinitely many solutions ?

(2 marks)

iii) have no solution ?

(2 marks)

Question 2

(a) Consider a two-storey building subject to earthquake oscillations. The period, T, of natural vibrations is given by $T = \frac{2\pi}{\sqrt{-\lambda}}$ where λ is the eigenvalue of a given matrix $A = \begin{pmatrix} -20 & 10 \\ 10 & -10 \end{pmatrix}$. Find the period, T.

(8 marks)

(b) Given that the matrix **M** which represents reflection in the line y=2x.

(i) Find the matrix operator **M.**

(2 marks)

(ii) The triangle whose vertices are A (5 , 5) , B (5 , 10) and C (10 , 5) is mapped onto A' B' C' by this transformation **M**. Find the coordinates of A', B' and C'.

(4 marks)

(iii) Draw the triangle ABC, the image A' B' C' and the graph of line y=2x on the graph paper provided to illustrate the effect of the transformation **M**.

(3 marks)

(iv) After the reflection in the line y=2x, a rotation of 270^0 about the origin is taking place. Write down the matrix R which represents the rotation of 270^0 about the origin, and hence find the matrix which represent the combined transformation.

(3 marks)

Question 3

(a) Given that $V = 240\angle 120^\circ$ and $z = (5 + j8)$.

Find $I = \dfrac{V}{z}$ in rectangular form.

(5 marks)

(b) (i) Evaluate $\dfrac{32}{j^3 - 3j}$.

(5 marks)

(ii) Hence, solve the following equation where z is a complex number in rectangular form.

(10 marks)

$$Z^2 = \frac{32}{j^3 - 3j}$$

Question 4

(a) Given that *a, b* and *c* are real numbers in the polynomial

$$P(z) = 2z^4 + az^3 + bz^2 + cz + 3$$

Determine the value of *a, b* and *c* such that the numbers 2 and *j* are the roots of $P(z)$.

(10 marks)

(b) The transform of a signal is given by $F(s) = \dfrac{6s}{s^2 + 9}$.

Decompose $F(s)$ completely in the **Complex Domain**.

(10 marks)

Question 5

(a) Three forces are acting on a ball shown in **Figure 1**. Calculate the magnitude and the direction of the resultant force to the horizontal line.

(10 marks)

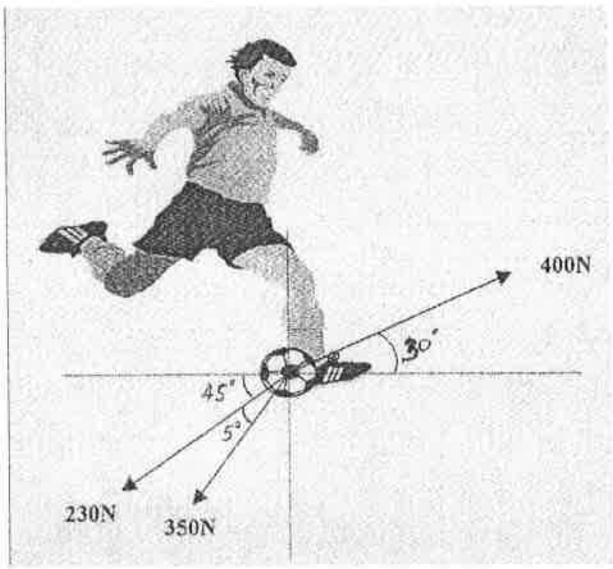
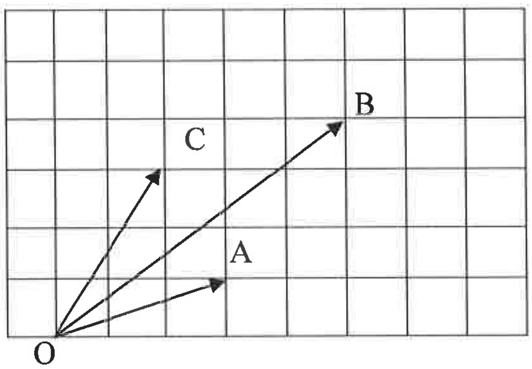


Figure 1

(b) OABC is a parallelogram such that $\vec{OA} = 3\underset{\sim}{i} + \underset{\sim}{j}$ and $\vec{OC} = 2\underset{\sim}{i} + 3\underset{\sim}{j}$



(i) Determine unit vector in the direction of $\vec{OA}$.

(2 marks)

(ii) Find $\vec{OB}$ in the form of $x\underset{\sim}{i} + y\underset{\sim}{j}$.

(3 marks)

(iii) Calculate the angle, $\angle OAB$.

(5 marks)

Question 6

(a) A cat is sitting on the ground at the point (1,4,0) watching a squirrel at the top of a tree. The tree is one unit high and its base is at the point (2,4,0). Find the following displacement vectors :

(i) From the bottom of the tree to the cat.

(3 marks)

(ii) From the cat to the squirrel.

(3 marks)

(b)

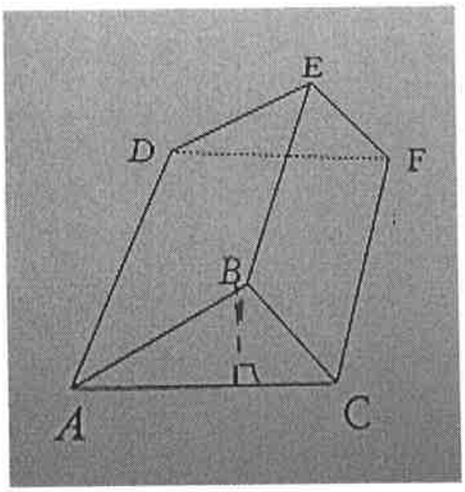


Figure 2

Figure 2 shows a right prism with triangular ends ABC and DEF, and parallel edges AD, BE, CF. Given that A=(2,7,-1) , B=(5,8,2) C=(6,7,4) and D(12,1,-9).

(i) Determine $\vec{AB} \times \vec{AC}$.

(7 marks)

(ii) Find $\left(\vec{AB} \times \vec{AC}\right) \bullet \vec{AD}$

(5 marks)

(iii) Hence, calculate the volume of the prism.

(2 marks)

END OF QUESTION

APPENDIX 1

STANDARD TRANSFORMATIONS

(1)	Rotation through an angle , θ , about the origin	$M = \begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix}$
(2)	Rotation through $\frac{\pi}{2}$ ***clockwise*** about the origin	$M = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$
(3)	Rotation through $\frac{\pi}{2}$ ***anti -clockwise*** about the origin	$M = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$
(4)	Enlargement / Reduction by a factor of k along the x – axis	$M = \begin{pmatrix} k & 0 \\ 0 & 1 \end{pmatrix}$
(5)	Enlargement / Reduction by a factor of k along the y - axis	$M = \begin{pmatrix} 1 & 0 \\ 0 & k \end{pmatrix}$
(6)	Enlargement / Reduction by k units	$M = \begin{pmatrix} k & 0 \\ 0 & k \end{pmatrix}$
(7)	Reflection in the **x-axis**	$M = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$
(8)	Reflection in the **y-axis**	$M = \begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix}$
(9)	Reflection in the **line** : $y = x$ or $y - x = 0$	$M = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$
(10)	Reflection in the **line** : $y = -x$ or $y + x = 0$	$M = \begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix}$

(11)	Shear of θ^{O} in the direction O_x	$M = \begin{pmatrix} 1 & \tan\theta \\ 0 & 1 \end{pmatrix}$
(12)	Shear of θ^{O} in the direction Oy	$M = \begin{pmatrix} 1 & 0 \\ \tan\theta & 1 \end{pmatrix}$
(13)	Reflection in the line : $y = mx$ or $y = x\tan\theta$ NOTE : $m = \tan\theta$	$M = \begin{pmatrix} \cos 2\theta & \sin 2\theta \\ \sin 2\theta & -\cos 2\theta \end{pmatrix}$ where : $\cos 2\theta = \dfrac{1-\tan^2\theta}{1+\tan^2\theta} = \dfrac{1-m^2}{1+m^2}$ $\sin 2\theta = \dfrac{2\tan\theta}{1+\tan^2\theta} = \dfrac{2m}{1+m^2}$
(14)	Rotation about y-axis (measured from z-axis)	$\begin{pmatrix} \cos\theta & 0 & \sin\theta \\ 0 & 1 & 0 \\ -\sin\theta & 0 & \cos\theta \end{pmatrix}$
(15)	Rotation about z-axis (measured from x-axis)	$\begin{pmatrix} \cos\varphi & -\sin\varphi & 0 \\ \sin\varphi & \cos\varphi & 0 \\ 0 & 0 & 1 \end{pmatrix}$
(16)	Rotation about x-axis (measured from y-axis)	$\begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos\psi & -\sin\psi \\ 0 & \sin\psi & \cos\psi \end{pmatrix}$