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FINAL
Examination Paper

(COVER PAGE)

Session : **January 2016**

Programme : Diploma in Electrical and Electronic Engineering (DEEI)

Course : **MAT 1123: Engineering Mathematics 3**

Date of Examination : 16 March 2016 (Wednesday)

Time : 8:00am – 10:00am

Duration : 2 Hours   Reading Time : Nil

Special Instructions :

This paper consists of **FIVE (5)** questions. Answer any **FOUR (4)** questions in the answer booklet provided. All questions carry equal marks.

IMPORTANT NOTE : THIS PAPER SHOULD NOT BE TAKEN OUT OF THE EXAMINATION HALL

Materials Permitted :

Non-programmable calculator

Materials Provided :

Formula Booklet 1

Examiner(s) : **Mr. Chan Ah Wah**

Moderator : Dr. Ch'ng Pei Eng

This paper consists of 5 printed pages, including the cover page.

INTI INTERNATIONAL COLLEGE PENANG

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING (DEEI)

MAT1123 ENGINEERING MATHEMATICS 3

FINAL EXAMINATION : JANUARY 2016 SESSION

Instructions

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Question 1

(a) Consider the following system of linear equations :

$$\begin{aligned} 2x + \ \ y \qquad &= -1 \\ x + 2y + 3z &= \ \ 1 \\ 3x + 8y + \beta z &= \ \ 2 \end{aligned}$$

By using rank test, determine the value(s) of β if the system has NO solution .

[7 marks]

(b) Use Cramer's rule to solve for the value of z in the system below :

$$\begin{aligned} 2x + \ \ y - 2z &= \ \ 10 \\ x + 2y + \ \ z &= \ \ 2 \\ 3x - \ \ y + 3z &= -8 \end{aligned}$$

Do NOT solve for x and y .

[5 marks]

(c) Given the matrix $\mathbf{A} = \begin{bmatrix} 4 & -6 & 2 \\ 0 & -2 & 2 \\ 0 & -1 & 1 \end{bmatrix}$. Find the eigenvalues and eigenvectors of $\mathbf{A}$.

[13 marks]

Question 2

(a) Given a homogeneous system as follows :

$$4x + y + kz = 0$$
$$x + y - 2z = 0$$
$$x - 2y + 13z = 0$$

Find the value of k if the homogeneous system has non-trivial solutions .

[5 marks]

(b) Evaluate the following determinant :

$$\begin{vmatrix} 1 & 1 & 2 & -3 \\ 3 & 4 & -1 & 5 \\ 4 & 5 & 1 & 2 \\ 1 & 1 & 2 & 1 \end{vmatrix}$$

[6 marks]

(c) Determine $\operatorname{adj}(\mathbf{A})$ if matrix $\mathbf{A}$ is given by

$$\mathbf{A} = \begin{bmatrix} 1 & 0 & -2 \\ -3 & 1 & 4 \\ 2 & -3 & 4 \end{bmatrix}.$$

Show all your workings.

[6 marks]

(d) Rearrange, if necesssary, the following system of linear equations, and then use Gauss-Seidel method to solve it . Compute three (3) iterations, starting with the initial guess $x_1^{(0)} = 1$, $x_2^{(0)} = 1$, $x_3^{(0)} = 1$. Keep 4 decimal places in all calculations .

$$x_1 - x_2 + 9x_3 = 14$$
$$8x_1 - x_2 + 2x_3 = 21$$
$$2x_1 - 11x_2 - x_3 = 36$$

[8 marks]

Question 3

(a) Given the scalar field $\phi(x, y, z) = x^2y^2z + yz^3$, find the directional derivative of ϕ at the point $(1, -1, -1)$ in the direction of the vector $\mathbf{A} = \mathbf{i} + 2\mathbf{j} + \mathbf{k}$.

[6 marks]

(b) Given $\mathbf{F} = (x + y)\mathbf{i} - 2y\mathbf{j}$, evaluate $\int_C \mathbf{F} \bullet d\mathbf{r}$ from $(0,1)$ to $(1,2)$ along

(i) the straight line from $(0,1)$ to $(1,2)$

(ii) the parabola $x = t,\ y = t^2 + 1$.

[9 marks]

(c) Use Gauss' theorem to evaluate $\iint_S \mathbf{F} \bullet \mathbf{n}\, dS$ where $\mathbf{F} = xy\mathbf{i} - xz\mathbf{j} + 3yz\mathbf{k}$ and S is the closed surface of the region bounded by the planes $z = 0$, $z = 4 - y$, $y = 0$, $y = 2$, $x = 0$, and $x = 3$.

[10 marks]

Question 4

(a) Given that $F = y^3\mathbf{i} + (3xy^2 + z^2)\mathbf{j} + 2yz\mathbf{k}$. Show that $\mathbf{F}$ is a conservative vector field.

[4 marks]

(b) Use Green's theorem to solve

$$\oint_C (y^2 - 2xy)\, dx + (x + 2xy)\, dy$$

where C is the counter clockwise oriented boundary of the region R bounded by the lines $x = 0$, $y = x$, and $y = 1$. Hint : convert the line integral to a double integral.

[10 marks]

(c) Let $S : x^2 + y^2 = 4,\ x \geq 0,\ y \geq 0$ be a cylindrical surface in the first octant bounded by the planes $x = 0$, $y = 0$, $z = 1$, and $z = 3$. Suppose a force $\mathbf{F} = z\mathbf{i} + x\mathbf{k}$ acts on the surface and around its boundary. Evaluate $\iint_S \mathbf{F} \bullet \mathbf{n}\, dS$, where $\mathbf{n}$ is the outward pointing unit normal vector to the surface S.

[11 marks]

Question 5

(a) Let $\phi = xy^3 + yz^2$ be a scalar field . Find $\nabla \bullet (\nabla\phi)$ at the point $(1,\ 2,\ 1)$.

[5 marks]

(b) Given the double integral $\int_0^1 \int_x^1 \sin\left(\frac{\pi y^2}{2}\right) dydx$

(i) Sketch the region of integration

[2 marks]

(ii) Evaluate the double integral by interchanging the order of integraion .

[5 marks]

(c) Sketch the graph of the periodic function $f(x)$ for $-5\pi < x < 5\pi$ and expand it in a Fourier series .

$$f(x) = x + \pi, \quad -\pi < x < \pi$$
$$f(x) = f(x + 2\pi)$$

[13 marks]

End of Paper

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