FIJI NATIONAL UNIVERSITY
College of Engineering, Science & Technology

SCHOOL OF ELECTRICAL & ELECTRONICS ENGINEERING

BACHELOR OF ENGINEERING
(Telecom & Networking)

EEE701 – Fields and Waves

SEMESTER 1, 2016

DAY/DATE: As timetabled DURATION : Three hours
ROOM: As timetabled

INSTRUCTION TO STUDENTS

1. You are allowed 10 minutes extra reading time during which you are **NOT** to write.
2. This paper has **TWO** sections. Answer **ALL** questions in Section A and in Section B
3. **Begin the answer to each Question** on a fresh page and use both sides of the sheet.
4. Write clearly the number of the question attempted on the top of each sheet
5. Write your candidate number at the top of each sheet & attach them.
6. Insert all written foolscaps, graph paper etc. in their correct sequence and secure with a string.
7. All sheets of paper on which rough/draft work has been done, cross it through and attach all of them to your answer scripts.
8. Where ever possible, draw clear neat diagrams

Number of pages including instruction page = 5

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Useful constants: $\varepsilon_o = 8.854 \times 10^{-12}$ Fm^{-1} $\mu_o = 4\pi \times 10^{-7}$ Hm^{-1}

Section A

Answer **ALL** questions

Question A. 1

i) In a Cartesian coordinate system, the coordinates of points A and B are (0, 2, 3) and (–3, 4,7) respectively.

a) Calculate the distance AB

(3 marks)

b) Calculate the unit vector from A to B $(\overrightarrow{AB})$

(5 marks)

ii) *a*) State the Stokes theorem in vector calculus as an equation. Define all the quantities in the equation

(3 marks)

b) In Cartesian coordinates, a vector field is specified as $\mathbf{A} = (2x)\,\mathbf{i}_y$

Evaluate curl A ($\equiv \nabla \times \mathbf{A}$).

(3 marks)

c) Verify the Stokes theorem for the rectangular closed path shown in Figure 1. The coordinates of the vertices are indicated

(6 marks)

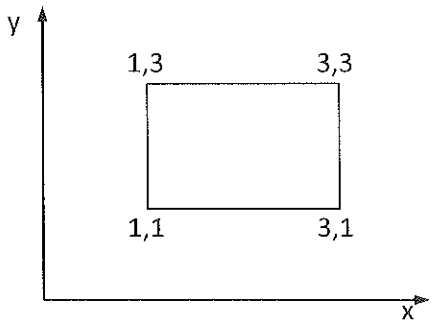

Figure 1

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Question A. 2

i) Describing all the symbols used, state the Coulomb's law and the Gauss' law in electrostatics. Explain how the Coulomb's law lead to the Gauss, law.

(7 marks)

ii) A sphere of radius 40 cm has a uniform charge density of 32 nC m^{-3}. Calculate the magnitude of the electric field at points M 50 cm and N 30 cm from the centre of the sphere and O the centre of the sphere. Draw clear diagrams to show the sphere of charge, the points M, N and O and the **directions of the electric fields**.

(6 marks)

iii) A circular hoop of radius 12 cm has a uniform charge distribution of 2 nC m^{-1}.

a) Calculate the total the total charge on the hoop.

(2 marks)

b) Calculate the electric field at the centre of the hoop. With a clear diagram **Explain** your answer.

(5 marks)

Question A. 3

i) *a)* State the Biot-Savart's law in magnetism. Illustrate the law by a suitably labelled diagram.

(6 marks)

b) An infinitely long straight wire carries a constant current I. Derive an expression for the magnetic induction field **B** at a point P whose perpendicular distance from the wire is r_o.

(8 marks)

c) Write down the four Maxwell's equations. State which fundamental laws in electromagnetism leads to these equations. (It is **NOT** necessary to state the laws).

(6 marks)

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Section B

Answer **ALL** questions

Question B. 1

i). Giving suitable diagrams, explain the mode of propagation of electromagnetic waves in free space, coaxial transmission lines and twin wire transmission lines.

(5 marks)

ii) Define the **distributed parameters** of a transmission line.

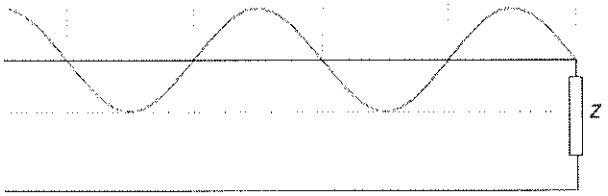
(4 marks)

iii) For a transmission line having negligible resistance and conductance, the inductance and capacitance per unit lengths are 330 nH/m and 75 pF/m respectively.

a) Calculate the "*characteristic impedance* (Z_o)" of the line.

(3 marks)

b) The transmission line is connected to a load Z. The amplitude of the voltage waves incident on the load and reflected from the load are A and B satisfy the equation $\frac{Z}{Z_0} = \frac{A+B}{A-B}$. The incident wave is 50 sin 300 t. The incident wave is shown the figure.



Calculate the amplitude and phase angle of the reflected wave for the following loads (Z) and draw the incident and the reflected wave on the same diagram for each case.

a). $Z = 40\Omega$; *b*). $Z = 66.3\Omega$

c). Complex load of (100Ω + Inductance L (40 mH) ⇒ 

(8 marks)

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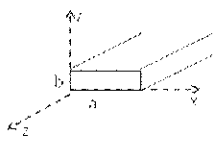
Question B. 2

i) The cross-section of a wave guide is shown in the figure. For EM waves inside a wave guide, the propagation coefficient P is given by:



$$P^2 = \left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2 - \varepsilon_0\varepsilon_r\mu_0\mu_r\omega^2 \text{ and } P = \alpha + j\beta$$

where α is the attenuation coefficient and β is the phase coefficient. m and n are the mode numbers.

Explain the condition for EM wave propagation. **Giving the reasons** state the lowest frequency of propagation.

(8 marks)

ii) *a*) What are the different types of optical fibers used in communication? Give labeled diagrams of the cross sectional profile of the refractive indices of the different types of "*optical fibers*" used in communication.

(5 marks)

b) What is the significance of "*numerical aperture*" in optical communication?

The refractive indices of the "*fiber*" and the "*cladding*" are 1.5 and 1.35 respectively. Calculate the numerical aperture of the fiber.

(4 marks)

iii) Explain the "*bending*" of EM waves by the ionosphere

(3 marks)

THE END