BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT OF ENGINEERING AND PHYSICS

PROGRAMME BACHELOR OF SCIENCE HONOURS DEGREE IN ELECTRONIC ENGINEERING

COURSE CODE: EEE2210/EEE3201 (1) NARRATION: ELECTROMAGNETIC THEORY

DURATION: 3 HOURS TOTAL MARKS: 100

INSTRUCTIONS TO CANDIDATES

1. Answer any **FIVE (5) questions**
2. The question paper **contains SEVEN (7)** questions
3. Each question carries **20 marks**
4. Special Requirements: Scientific Calculator, rule, pen, pencil

Constants

$\mu_o = 4_\pi \, x \, 10^{-7}$, $\varepsilon_o = 8.854 \, x \, 10^{-12} \, F/m$

1(a) Given vectors $\vec{A} = 3\hat{x} + 9\hat{y} + 5\hat{z}$ and $\vec{B} = \hat{x} - 7\hat{y} + 4\hat{z}$, calculate $\vec{A}.\vec{B}$ and $\vec{A}$ x $\vec{B}$ using vector components and find the angle between $\vec{A}$ and $\vec{B}$ using both products. [5]

(b) Find the gradient of $T = x^2y+z^3$ [2]

(c) Find the divergence of $\vec{V} = xy\hat{x} - 2y^2z\hat{y} + z^3\hat{z}$ [2]

(d) Find the curl of $\vec{V} = xy\hat{x} - 2y^2z\hat{y} + z^3\hat{z}$ [4]

(e) Prove $\nabla \times (\nabla T) = 0$. [3]

(f) Define mathematically the following integrals

(i) Surface integral [2]

(ii) Line integral [2]

2(a) State Maxwell's equations in integral from [5]

(b) Consider the vectors in rectangular coordinate system. Find the angle between $\boldsymbol{A}$ and $\boldsymbol{B}$ with the help of vector product. $\boldsymbol{A}$=$3a_x$+$4a_y$+$0a_z$ $\boldsymbol{B}$=$4a_x$+$3a_y$+a_z [5]

(c) Find the line integral of the vector $\vec{F} = (x^2 - y^2)\hat{a}_x + 2xy\hat{a}_y$ around a square of side a which has a corner at the origin, one side on the x axis and the other side on the y axis. [5]

(d)(i)Write down the mathematical statement of Stoke's Theorem [2]

(ii) State the significance of Stoke's Theorem [2]

(e) What is cross product of a_x x a_y [1]

3(a) State any three properties of charges [3]

(b) Define Coulomb's law mathematically and define parameters involved in the equation. [3]

(c) Q_1=$\frac{1}{9}\mu C$ is located at the origin and Q_2=$100mC$ is located at (8,6,0) in free space.

Find F_2 and F_1. [6]

(d) Find the magnetic field intensity at (0,4,0), caused by the following source. $Id\ell$=64×10−3 A-m at O (0,0,0) [3]

(e) The electric potential in Cartesian coordinates is given by $V(x, y, z) = 2x^2 2y + 3z^2$. Determine the (i) numerical value of the voltage at point $P(1,3, 2)$, (ii) the electric Field. [5]

4(a) For a linear, homogeneous material medium, derive Poisson's and Laplace's equations from Gauss' law. [5]

(b) If Coulomb's force, $F = 2a_x + a_y + a_z$N, is acting on a charge of 10C, find the electric field intensity, its magnitude and direction. [6]

(c) A charge of 12 C has velocity of $5a_x + 2a_y - 3a_z$ m/s. Determine F on the charge in the field of (a) $E = 18a_x + 5a_y + 10a_z$V/m (b) $B = 4a_x + 4a_y + 3a_z$ wb/m^2. [4]

(d) A current element 4 cm long is along y-axis with a current of 10 mA flowing in y-direction. Determine the force on the current element a_x due to the magnetic field $H = \frac{5a_x}{\mu}$ [5]

5(a) State Biot-Savart's Law [2]

(b) Find the magnetic field intensity at (0,4,0), caused by the following source. $Id\ell$ = 64×10^{-3} A-m at O(0,0,0) [3]

(c) (i)What are the boundary conditions for electric field and electric field density at the interface between two perfect dielectrics [2]

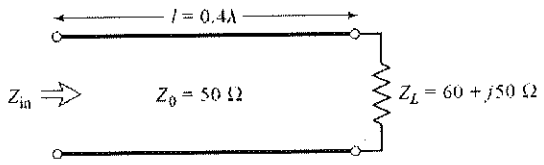
(ii) What are the magnetic boundary conditions at the same interface [2]

(iii) What the electric field boundary condition at the conductor-dielectric interface [2]

(d)Write down Maxwell's four equations and briefly explain the meaning/significance of each. [8]

(e) Write integral form of Ampere's circuit Law. [1]

6(a) Use the Smith chart on the last page of the question paper to find the following quantities for the transmission line circuit shown below and attach the smith chart to the answer booklet when you have finished.



i. The SWR on the line. [2]

ii. The reflection coefficient at the load. [2]

iii. The load admittance. [2]

iv. The input impedance of the line. [2]

(b) Sketch and label an equivalent circuit for a section of loss free transmission line. [2]

(c) Describe any two primary coefficients of a transmission line [4]

(d) A 300 m long line has the following constants: R = 4.5 kΩ, L = 0.15 mH, G = 60 Siemens, C = 12 nF, operated at frequency 6 MHz. Find the propagation constant, characteristic impedance of the line. [6]

7(a) $\boldsymbol{E}$ = 377 sin (109 t − 5y) a_z is travelling in a medium characterized by $\mu = \mu_0$ find ε_r, v, λ, η [6]

(b) The time varying magnetic flux in the vicinity of a conductor is $\emptyset$=5cos100πt mwb. Find voltage induced in the conductor at t=1 $m\ sec$. [3]

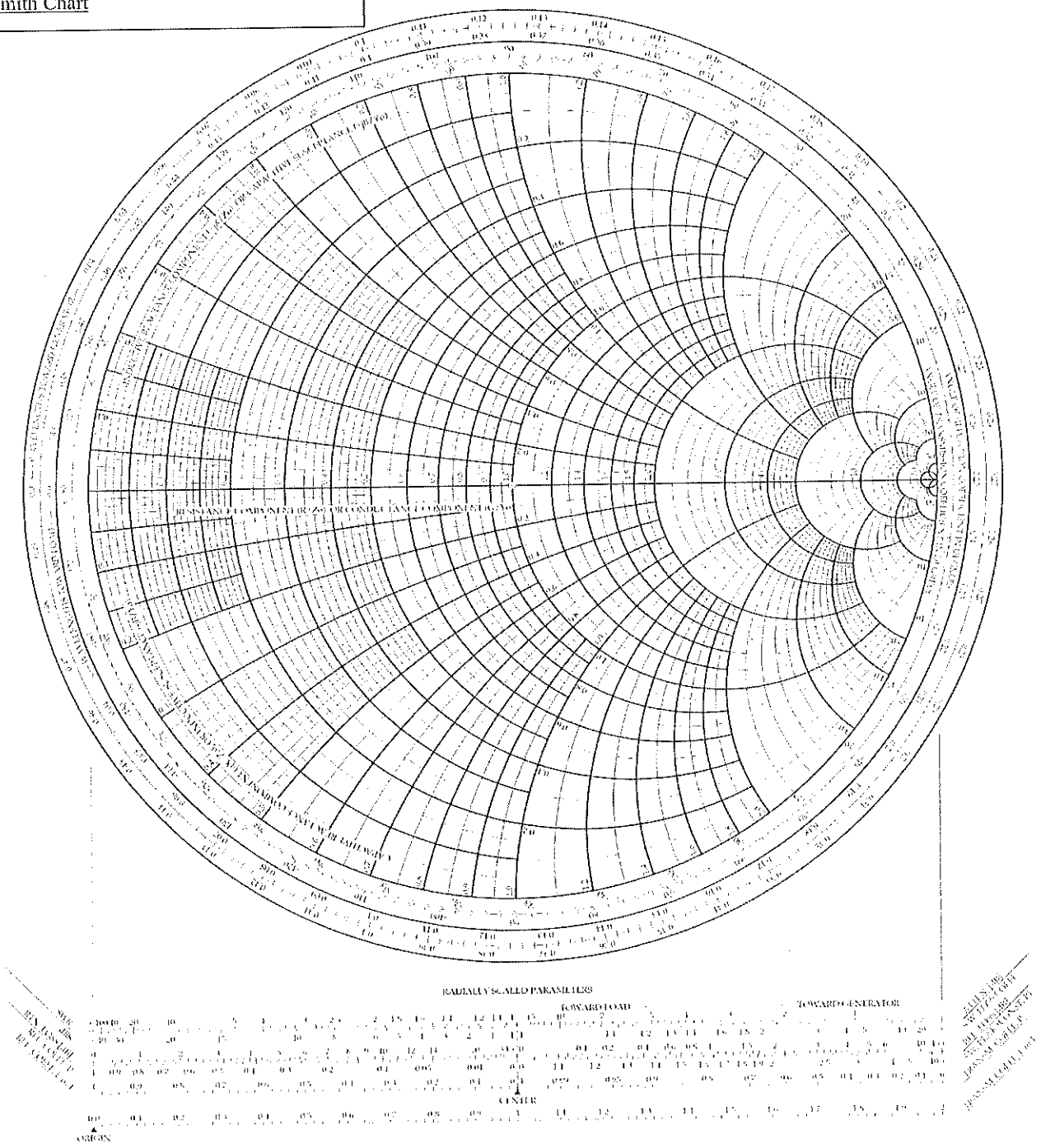
(c) If $\boldsymbol{E}$=8 sin (6283t+6z) a_x V/m. Find $-\frac{\partial B}{dt}$ [3]

(d) Given coax (coax cable) with an inner conductor of radius a and a grounded outer conductor of radius b,

(i) Sketch the electric flux in an end view of the coax. [4]

(ii)Compare the charge on the outer conductor with respect to a total charge of Q on the inner conductor and give reasons. [4]

Smith Chart



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