BITS,Pilani-Dubai

2nd Semester,2010-11

Course Title/Course No.: ELECTROMAGNETIC FIELDS AND WAVES (EEE C433)

IIIrd Year(EEE) **Comprehensive Examination**

(F.M-80, Weightage—40%) Date— 29/05/2011 ; Duration—3 Hours.

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(1) In free space with $\epsilon_0 = 8.854(10^{-12})$ F/m and $\mu_0 = 4\pi(10^{-7})$ H/m, it is given that $\vec{E}$=C Sin (12y) Sin(az) Cos{2(10^{10}) t} $\vec{1_x}$ Volts/meter for a region where "C" and "a" are unknown. Using Maxwell's equations find numerical value for the coefficient "a" where a>0. [12 marks]

(2)A 2.0 GHz uniform plane wave has an amplitude, E_{y0} =1.4 kv/meter and it is propagating in the $\vec{1_z}$ direction. The given data are : $\epsilon' = 3.0(10^{-11})$ F/m , $\epsilon'' = 1.6(10^{-11})$ F/m, $\mu = 2.5(10^{-6})$ F/m . Calculate: (a) E_y at (0, 0 ,1.8 cm) at t=0.2 ns (b) H_x at (0,0 ,1.8 cm) at t=0.2 ns [5+3 marks]

(3)(a) In context to **" Wave propagation in Dielectrics "**, use the standard expression for intrinsic impedance. Considering the case of a conductive material having conductivity, "σ" , after necessary mathematical derivation, prove that "σ" can be expressed as $\sigma = \omega \epsilon''$.

(b) Consider the case of Reflection and Refraction phenomena of uniform plane wave propagation. It is given that region-1 is a perfect dielectric and region-2 is a perfect conductor. The uniform plane wave in region-1 is normally incident on the planar boundary separating region-1 and region-2. After necessary mathematical derivation and using the findings of question 3(a), establish that " **NO TIME VARYING MAGNETIC FIELD CAN EXIST IN REGION-2**". ----------[6+6 marks]

(4) With reference to "Transmission Lines of Finite Length", one receiver of 200 ohm resistance value is connected in parallel with a capacitive impedance of –j300 ohm. This resistance-capacitance combination is treated as a load for the transmission line having a length of 4.0 meter. Characteristic Impedance (Z_0) of the transmission line is 300 ohm. Source(operating) frequency is 100 MHz and velocity of propagation is 2.5(10^8) m/sec. Calculate: (a) Reflection Coefficient (Γ); (b) V.S.W.R (c) Input Impedance(Z_{in}) (both magnitude and phase) (d) Source Current(in polar form) for a source voltage of 50 volts and Thevenin impedance of 250 +j0 ohm.---- [12 marks]

[P.T.O]

(5) Develop the **" SMITH CHART"** (properly labeled diagram) of Transmission line after deriving all equations in detail. Initiate the analysis using the relation, $\Gamma=(Z_L - Z_0)/ (Z_L + Z_0)$-- [9+4 marks]

(6) A uniform plane wave in region-1 is normally incident on the planar boundary separating region-1 and region-2. If $\epsilon_1'' = \epsilon_2'' = 0$, while $\epsilon_{r1}' = (\mu_{r1})^3$ and $\epsilon_{r2}' = (\mu_{r2})^3$, find the ratio "$(\epsilon_{r2}'/ \epsilon_{r1}')$" if 20% energy in the incident wave is reflected at the boundary. There are two possible answers.---------- [8 marks]

(7) In context to a **"Parallel Plate Wave-Guide"**, prove that Group Velocity, v_{gm} can be expressed as $v_{gm} = (c/n)\ \text{Sin}\ \theta_m$, where the symbols have their usual meaning. [7 marks]

(8) Draw the labeled diagram of a **"Transmitting Antenna"** showing all the regions and also draw the labeled diagram of **"Antenna Field Pattern(Radiation)"** showing r,θ,ϕ coordinates.-- ---------- [8 marks]

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Course Title/Course No.: ELECTROMAGNETIC FIELDS AND WAVES (EEE C433)

IIIrd Year(EEE) Test-2(OPEN BOOK) (F.M-20, Weightage—20%) /Date—15/05/2011

Marks distribution: Q1)—9 Marks, Q2)—6 Marks Q3)—5 Marks

Instructions: Prescribed Text Book and handwritten notes only will be allowed

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(1) The incident voltage wave on a certain lossless transmission line for which Z_0= 50.0 ohms and phase velocity (v_p) = 2(10^8) m/s is $V^+(z,t)$ =200 cos ($\omega t-\pi z$) volts. (a) Find ω (b) Find $I^+(z,t)$. The section of line for which z>0 is replaced by a load Z_L= 50.0 +j 30.0 Ω at z=0 . Find : (c) Reflection Coefficient (Γ); (d) $V_s^-(z)$; (e) V_s at z= -2.2 metre

(2) In context to "Polarization", given a wave for which $E_s = 15\, e^{-j\beta z}\, \vec{1}_x + 18\, e^{-j\beta z}\, e^{j\phi}\, \vec{1}_y$ Volts/meter in a medium characterized by complex intrinsic impedance, η : (a) Find the expression for H_s , involving the term "η" ; (b) determine the average power density in W/m^2 (involving the term "η" or associated term)

(3) A 1 MHz uniform plane wave [in free space with ϵ_0 = 8.854(10^{-12}) and μ_0 = 4π(10^{-7})] is normally incident onto a freshwater lake (ϵ_r' =78 , ϵ_r'' =0 , μ_r = 1). Determine the fraction of incident power that is (a) reflected and (b) transmitted. (c) Determine the amplitude of electric field (as a fraction of E_{x10}^+) that is transmitted into the lake

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2nd Semester,2010-11

Course Title/Course No.: ELECTROMAGNETIC FIELDS AND WAVES (EEE C433)

IIIrd Year(EEE) Test-1 (E.M-25, Weightage—25%) /Date—27/03/2011

Duration = 50 min.

Marks distribution: Q1)—9 Marks, Q2)—6+2+1 Marks Q3)—7 Marks

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(1) A 50-cm. long wire is aligned with the positive x-axis direction. This wire moves in a plane represented by the equation : z=3 meter, with a velocity expressed as $\vec{v}=2\vec{1}_x+4\vec{1}_y$ meter/sec. in a magnetic field. This magnetic field has a vector potential expressed as $\vec{A}= (6z+3xyz^2)\,\vec{1}_x + 6\,\vec{1}_y + (3x^2\,yz)\vec{1}_z$ Webers/meter. Calculate the e.m.f induced in the wire.

(2) Based on Maxwell's equations derive the Poynting's Theorem(with mathematical steps in detail) and hence establish the expression for the Poynting Vector. Also state the physical significance of each term in the right hand side of the above-said theorem.

(3) Let $jk = 0.2 + j1.5\ \text{m}^{-1}$ and $\eta = 450 + j60\ \Omega$ for a uniform plane wave propagating in the $\vec{1}_z$ direction. If $\omega = 300$ Mrad/s, find μ, ϵ', and ϵ'' for the medium.

[SET- A] BITS,Pilani-Dubai

Course Title/Course No.: ELECTROMAGNETIC FIELDS AND WAVES (EEE C433)

2nd Semester, 2010-11 ------Name of the student/Id No.----------

IIIrd Year(EEE) Quiz-II (F.M-14, Weightage—7%) **(Set- A)** /Date—20/04/2011

Marks distribution: Q3)—2 Marks, and other questions of 3 Marks each

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1.) Given that Z_L =150 ohm and Z_0 =300 ohm. Calculate "Reflection Coefficient" and " V.S.W.R"

2.) Given that Z_L =150 ohm and Z_0 =300 ohm and $\beta l=1.6\pi$ radians. Calculate Input Impedance(Z_{in}) .

3.) Prove that the Transmission Coefficient(τ) can be expressed as $\tau= 2(Z_L)/(Z_0 + Z_L)$

[P.T.O]

SET-A

Name/Id No.- - - - -

4.) In a transmission line, the following relation is given:

$\Delta V/\Delta Z = -[RI + L(\partial I/\partial t) + (1/2)\ L(\partial \Delta I/\partial t) + (1/2)\ (R\Delta I)$, where the symbols have their usual meanings.

Assuming that ΔZ approaches zero, prove that :

$\partial V/\partial Z = -[RI + L(\partial I/\partial t)]$.

5.) Draw the labeled diagram of Smith Chart.

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2nd Semester, 2010-11 ------Name of the student/Id No.----------

Duration = 20 min.

IIIrd Year(EEE) Quiz-I (F.M-16, Weightage—8%) (Set- A) /Date—02/03/2011

Marks distribution: Q1)—1 Mark, Q7)—3 Marks and other questions-- 2 Marks each

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1.) Prove that the unit of POYNTING VECTOR will be Watts /m^2 . [1 Mark]

2.) Fill in the blank: $\vec{\nabla}.(\vec{E}\times\vec{H})$ =----------+ $\vec{H}.(\vec{\nabla}\times E)$ [2 Marks]

3.) It is given that , $\vec{\nabla}\times\vec{H} = \epsilon_0\left(\frac{\partial\vec{E}}{\partial t}\right)$. What will be the value of conduction current density in such case? Show necessary mathematical formulations.

4.) Fill in the blank, showing the concerned derivations: $\left(\mu\vec{H}.\frac{\partial\vec{H}}{\partial t}\right)=\frac{\partial}{\partial t}\left(\text{----------}\right)$

5.) Between the two plates of a capacitor, there is no electrical connection. Still current flows due to external voltage supply to the capacitor. How does it happen without electrical connection? Explain mathematically using electromagnetic field equations either in Differential form or in Integral form.

6.) Write the wave equation of a uniform plane wave (T.E.M) in free space and write the name of each symbol. Which is the direction of wave propagation in the equation written?

[P.T.O]

7.) A capacitor is energized from a voltage source , $V = V_0 \cos \omega t$. The following are given: S=Surface area of capacitor ; ϵ = Permittivity of the dielectric medium ; d= Separation distance between the parallel plates of the capacitor; ω =Supply frequency in electrical radians /second;

Derive the expression for Displacement Current using the concept of Displacement Current Density.

8.) Write the necessary field equations (only) to reach the formulation for the Vector Helmholtz equation in free space. No complete derivation is necessary.