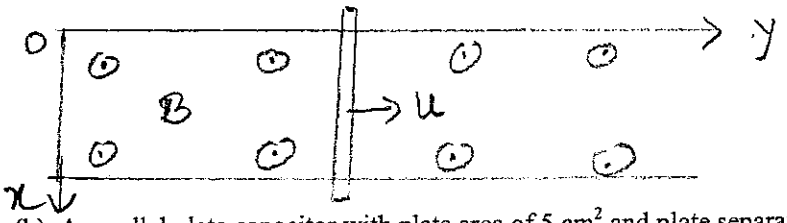
# BITS PILANI DUBAI CAMPUS
# SECOND SEMESTER 2011-12
# COMPREHENSIVE EXAMINATION

Course No: EEE C 433 Course Name: Electromagnetic fields and Waves

Weightage: 40 Max. Marks:40 Time: 3Hrs Date 12.6.2012

Q1.(a) A conducting bar can slide freely over two conducting rails as shown in the figure. Calculate the induced voltage in the bar if the bar is stationed at y=8 cm and B= $4\cos 10^6 t \ \hat{z}$ mWb/m$^2$ . (2)




(b) A parallel plate capacitor with plate area of 5 cm$^2$ and plate separation of 3mm has voltage $50 \sin 10^3 t$ V applied to its plates. Calculate the displacement current assuming $\varepsilon = 2\varepsilon_0$. (2)

Q2. (a) Write Maxwell's' equations in differential, integral and phasor form. (1)

(b) In a charge free region for which $\mu = \mu_0, \varepsilon = \varepsilon_0 \varepsilon_r, \sigma = 0$, $H = 5 \cos (10^{11} t - 4y) \hat{z}$ A/m find :

(i) $J_d$ and D and (ii) $\varepsilon_r$ (2)

Q3. In a certain region with $\mu = \mu_0$, $\varepsilon = 6.25\varepsilon_0$ and $\sigma = 0$, the magnetic field of an EM wave is $H = 0.6 \cos \beta x \cos 10^8 t \ \hat{z}$ A/m. Find $\beta$ and the corresponding E using Maxwell's' equations. (2)

Q4. A lossy dielectric has an intrinsic impedance of $200 \angle 30^0$ at a particular radian frequency w. If, at that frequency, the plane wave propagating through dielectric has the magnetic field component $H = 10 e^{-\alpha x} \cos (wt - 0.5 x) \hat{y}$ A/m , find E and $\alpha$. Determine the skin depth and wave polarization. (3)

Q5. In a lossless dielectric for which $\eta = 60\pi$ , $\mu_r = 1$, and $H = -0.1 \cos (wt - z) \hat{x} + 0.5 \sin (wt - z) \hat{y}$ A/m, calculate $\varepsilon_r$ , w and E. (3)

Q6. Given a uniform plane wave in air as

$E_i = 40 \cos (wt - \beta z) \hat{x} + 30 \sin (wt - \beta z) \hat{y}$ V/m

(a) Find $H_i$
(b) If the wave encounters a perfectly conducting plate normal to the z- axis at z = o , find the reflected $E_r$ and $H_r$.
(c) Calculate the time average Poynting vectors for $z \leq 0$ and $z \geq 0$. (3)

Q7 . An air transmission line has a characteristic impedance of 70 Ω and a phase constant of 3 rad/m at 100 MHz. Calculate the inductance per meter and capacitance per meter of the line. (3)

Q8. A distortion less line has $Z_0 = 60\ \Omega$, $\alpha = 20$ m Np/m, u =0.6c, where c is the speed of the light in a vacuum. Find R,L,G,C and $\lambda$ at 100 MHz. (3)

Q9. A coaxial line 5.6 m long has distributed parameters R = 6.5 Ω/m, L = 3.4 μH/m, G = 8.4 mS/m, and C = 21.5 pF/m. If the line operates at 2MHz, calculate the characteristic impedance and end to end propagation time delay? (3)

Q10. What are the differences among the following different modes of wave propagation: TEM mode, TE mode, TM mode, HE(Hybrid) mode. Explain with diagrams? (2)

Q11. In a rectangular waveguide for which a = 1.5cm, b = 0.8 cm, $\sigma = 0$, $\mu = \mu_0$ , $\varepsilon = 4\varepsilon_0$ ,

$$H_x = 2 \sin(\pi x/a) \cos(3\pi y/b) \sin(\pi\, 10^{11}\, t - \beta z)\ \text{A/m}\ ,$$

Determine

(a) The mode of operation (0.5)
(b) The cut off frequency (1)
(c) The phase constant β (1)
(d) The propagation constant γ (0.5)
(e) The intrinsic wave impedance η (1) (Total=4)

Q12. Calculate the dimensions of an air filled rectangular filled rectangular waveguide for which cut off frequencies for $TM_{11}$ and $TE_{03}$ modes are both equal to 12 GHz. At 8GHz, determine whether the dominant mode will propagate or evanesce in the waveguide. (3)

Q13.(a) Mention about any four different kind of antenna with diagrams. (1)

( b ) A magnetic field strength of 5 μ A/m is required at a point on $\Theta = \pi/2$ ,which is 2 Km from an antenna in air. Neglecting ohmic loss, how much power must the antenna transmit if it is a Hertzian dipole of length λ/25 . (3)

Given: $\mu_0 = 4\pi \times 10^{-7}$ , $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^{9}$

**BITS PILANI DUBAI CAMPUS**
**SECOND SEMESTER 2011-12**

Test-2 (Open Book)

Course No: EEE C 433 Duration: 50 Mints Weightage: 20%

**Course Name: Electromagnetic Fields and Waves** **Max Marks: 20** **Date: 13.5.2012**

**Note:** All the questions are compulsory.

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Q1. In a non magnetic material $\vec{H} = 30 \cos (2\pi \times 10^8 - 6x)\, \hat{y}$ mA/m. Find

(a) The intrinsic impedance

(b) The Poynting Vector

(c) The time average crossing the surface $x = 1,\ 0 < y < 2,\ 0 < z < 3$ m. (2x3=6)

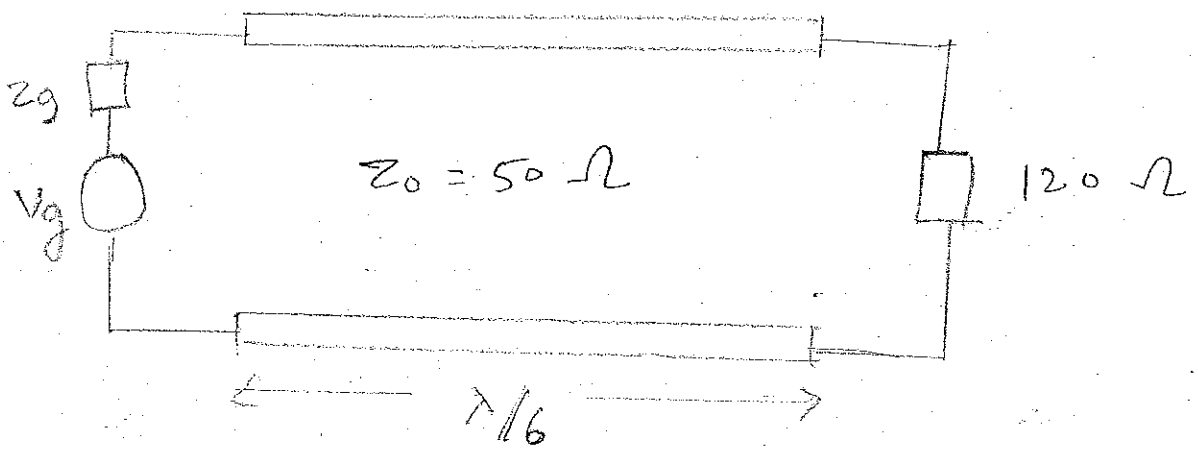
2.. A uniform plane wave in air normally incident on an infinite lossless dielectric material having $\varepsilon = 3\ \varepsilon_0$ and $\mu = \mu_0$. If the incident wave is $\vec{E_i} = 10 \cos (wt - \beta z)\, \hat{y}$ V/m , find

(a) reflection coefficient and transmission coefficient

(b) The total electric field and the time average power in both the regions (2+4=6)

Q3. A parallel polarized wave is incident from air to polystyrene with $\mu = \mu_0$, $\varepsilon = 2.6\ \varepsilon_0$ at Brewster angle. Determine the transmission angle. (3)

Q4. Refer to the lossless line shown in the figure. (a) Find reflection coefficient and standing wave ratio (b) Determine input impedance at the generator. (5)



**BITS PILANI DUBAI CAMPUS**
**SECOND SEMESTER 2011-12**

**Test-1(Closed Book)**

**Course No: EEE C 433** **Duration: 50 Mints** **Weightage: 25%**

**Course Name: Electromagnetic Fields and Waves** **Max Marks: 25** **Date: 22.3.2012**

**Note:** All the questions are compulsory.

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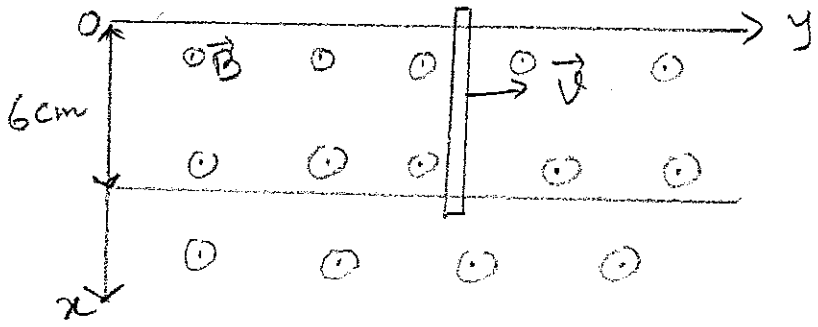
Q1. A conducting bar can slide freely over two conducting rails as shown in the figure. Calculate the induced voltage in the bar, if the bar slides at a velocity of $\vec{v}=20\,\hat{y}$ m/s and magnetic field $\vec{B} = 4\cos(10^6 t - y)\,\hat{z}$ m Wb/m$^2$. (5)




Q2. A medium is characterized by $\sigma = 0$, $\mu = \mu_0$, $\varepsilon = 4\varepsilon_0$ and the electric field is given by $\vec{E} = 20\sin(10^8 t - \beta z)\,\hat{y}$ V/m. Calculate (a) $\vec{H}$ (b) $\beta$ (4+5=9)

Q3. The electric and magnetic field in a lossy dielectric is given by

$\vec{E}(z,t) = E_0 e^{-\alpha z}\cos(wt - \beta z)\,\hat{x}$ and $\vec{H} = (E_0/\eta) e^{-\alpha z}\cos(wt - \beta z)\,\hat{y}$ where $\alpha$ is the attenuation constant. Show that

$\eta = \{jw\mu/(\sigma + jw\varepsilon)\}^{1/2}$, where symbols have their usual meanings. (5)

Q4.A transverse electromagnetic wave is travelling in a in a lossless dielectric medium for which intrinsic impedance $\eta = 60\pi$, $\mu_r = 1$ and

$\vec{H} = -0.1\cos(wt - z)\,\hat{x} + 0.5\sin(wt - z)\,\hat{y}$ A/m,

Calculate(a) $\varepsilon_r$,(b) angular frequency (w) (c ) electric filed $\vec{E}$. (2+2+2=6)

-----Good Luck----

**Name:** **Id No:**

# BITS PILANI DUBAI CAMPUS

**SECOND SEMESTER 2011-12 Quiz-2 (Closed Book)**

**Course Name: Electromagnetic field and waves** **Course No: EEE ~~426~~ C437** **Time: 20 Mints**

**Max Marks: 7** **Weightage:7%** **Date: 24.4.2012**

| | |
|---|---|
| Q1. | Write Poynting theorem stating the significance of each term (1) |
| Ans | |
| Q2. | A medium of intrinsic impedance 98.7 Ω having electric field $E = 4 \sin(2\pi x10^{-7} t - 0.8 x)\hat{z}$ V/m. Calculate the time average power carried by the wave (1) |
| Ans | |
| Q3 | In Q.No.2 , calculate the total power crossing 100 $cm^2$ of plane $2x + y = 5$ (1) |
| Ans | |
| Q4 | In free space ($z<0$), a plane wave with $H_i = 10 \cos(10^8 t - \beta z)\hat{x}$ mA/m is incident on a lossless medium ($\varepsilon=2\varepsilon_0$, $\mu = 8\mu_0$) in region $z>0$. Determine the reflection coefficient. (1) |
| Ans | |
| Q5 | In Q.No.4 calculate the reflected magnetic field vector (1) |
| Ans | |
| Q6 | In Q.No.4 calculate the reflected electric field vector (1) |
| Ans | |
| Q7 | In Q.No.4 calculate the amplitude of transmitted electric field (1) |
| Ans | |

Name: Id No:

# BITS PILANI DUBAI CAMPUS

SECOND SEMESTER 2011-12 Quiz-1 (Closed Book)

Course Name: Electromagnetic field and waves Course No: EEE 416 Time: 20 Mints

Max Marks: 8 Weightage:8% Date: 6.3.2012

| | |
|---|---|
| Q1. | A loop is rotating about the y-axis in a magnetic field B= $B_0$sinwt $Wb/m^2$ along x-axis. The voltage induced in the loop is due to<br>(a)Motional emf (b) Transformer emf (c) A combination of motional and transformer emf<br>(d) None of the above (0.5) |
| Ans | |
| 2. | Which of the following statements is not true of a phasor<br>(a)It may be scalar or vector (b) It is a time dependent quantity (c) A phasor $V_s$ may be represented as $V_0\angle\theta$<br>(d) It is a complex quantity (0.5) |
| Ans | |
| Q3 | The concept of displacement current was a major contribution attributed to<br>(a) Faraday (b) Lenz (c) Maxwell (d) Lorentz (e) Your Professor (0.5) |
| Ans | |
| Q4 | Given that A= $10\cos(10^8 t - 10x + 60^0)$ along Z-axis. Express A in phasor form. (0.5) |
| Ans | |
| Q5 | The flux through each turn of a 100 turn coil is $(t^3-2t)$ mWb, where t is in seconds. The induced emf (in volts) at t= 2s is (1) |
| Ans | |
| Q6 | Given that $B_s = (20/j)\hat{x} + 10\,e^{j2\pi x/3}\hat{y}$. Express $B_s$ in instantaneous form. (1) |
| Ans | |
| Q7 | Write the Maxwell's equations in differential form in free space in presence of charge and current. (1) |
| Ans | |

| | |
|---|---|
| Q8 | Write the Maxwell's equations in integral form inside a dielectric in presence of free charge and free current. (1) |
| Ans | |
| Q9. | Write all the four boundary conditions for E and B in presence of free charge and free current. (1) |
| Ans | |
| Q10 | In a medium characterized by $\sigma = 0$, $\mu = \mu_0$, $\varepsilon = \varepsilon_0$ and $E = 20 \sin(10^8 t - \beta z)\hat{y}$ V/m. Find H. (1) |
| .IS | |

**Rough Work:**