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# National Institute of Technology, Hamirpur (H.P.)

**Examination: B.Tech. End Semester Examination, December-2020**

Branch : Electrical Engineering Semester : III[rd]

Course : Electromagnetic Field Theory Code : EE-212

**Time: 02:00 Hours** **Maximum Marks: 50**

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**Instruction: Attempt all the questions.**

**Q.1.** (a) If $A = \rho \cos\phi\, a_\phi + \sin\phi\, a_\phi$, evaluates $\oint A.dl$ around the path shown in Figure 1. Confirm this by using Stokes's Theorem.

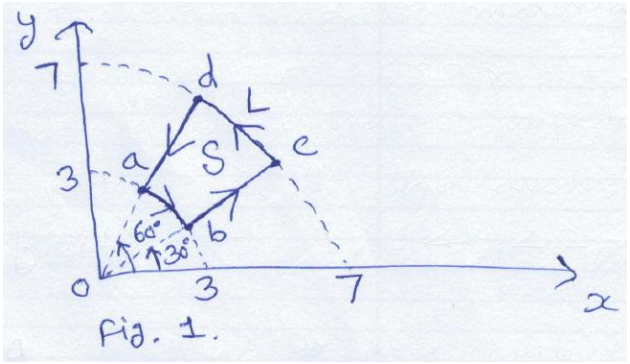

Fig. 1.

**[05 Marks]**

(b) A measurement were carried out in atmosphere, which shows that there is an E-field exists at the surface of the earth and at the height 2000 m, of the value 150 V/m and 75 V/m respectively. Calculate the mean space charge density in the atmosphere between zero and 2000 m altitude. **[05 Marks]**

**[Total = 10 Marks]**

**Q.2.** (a) State and explain the Biot-Savart's law and Ampere's circuital law for steady M-field in integral form and point form. **[05 Marks]**

(b) The electric field and magnetic field in free space are given by

$$E = \frac{70}{\rho}\cos(6\times10^7 t + \beta z)\, a_\phi\ V/m$$

$$H = \frac{H_0}{\rho}\cos(6\times10^7 t + \beta z)\, a_\rho\ A/m$$

Express these in phasor form and determine the constants $H_0$ and $\beta$ such that the fields satisfy Maxwell's equations. **[05 Marks]**

**[Total = 10 Marks]**

**Q.3.** (a) A lossy dielectric has an intrinsic impedance of $100\angle 60^o$ at a particular radian frequency$\omega$. If, at that frequency, the plane wave propagating through the dielectric has the magnetic field component

$$H = 15e^{-\alpha x}\cos(\omega t - \frac{1}{4}x)\, a_y\ A/m$$

Find $E$ and $\alpha$. Determine the Skin depth and wave polarization. **[05 Marks]**

(b) A uniform plane wave in air with

$$E = 5\cos(\omega t - 6x - 3z)\, a_y\, V/m$$

is incident on a dielectric slab $(z \geq 0)$ with $\mu_r = 1.0, \varepsilon_r = 3.8, \sigma = 0$. Find:

(i) The polarization of the wave
(ii) The angle of incidence
(iii) The reflected E-field
(iv) The transmitted H-field **[05 Marks]**

**[Total = 10 Marks]**

**Q.4.** (a) In a nonmagnetic material,

$$H = 30\cos(2\pi \times 10^8 t - 6x)\, a_y\, mA/m$$

Find:

(i) the intrinsic impedance,
(ii) the Poynting vector,
(iii) the time-average power crossing the surface $x = 1, 0 < y < 2, 0 < z < 3\ m$. **[05 Marks]**

(b) Consider the three lossless lines in Figure 2, if $Z_0 = 70\ \Omega$, calculate:

(i) $Z_{in}$ looking into line 1 (ii) $Z_{in}$ looking into line 2 (iii) $Z_{in}$ looking into line 3 (iv) reflection coefficient Γ.

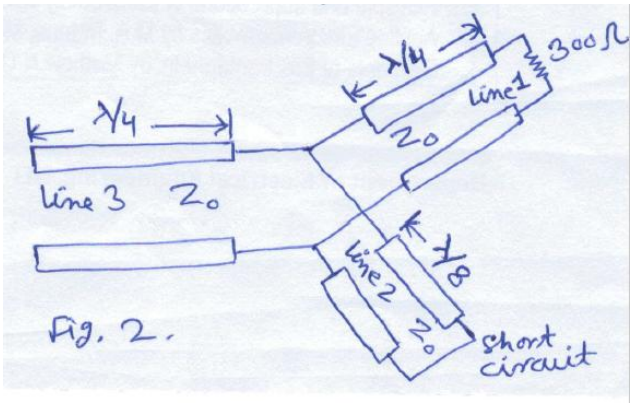

Fig. 2.

. **[05 Marks]**

**[Total = 10 Marks]**

**Q.5.** (a) In an air-filled rectangular waveguide with a = 2.286 cm and b= 1.016 cm, the $y-$component of the $TE$ mode is given by

$$E_y = \sin(^{2\pi x}/_{a})\cos(^{3\pi y}/_{b})\sin(10\pi \times 10^{10} t - \beta z) V/m$$

Find: (i) the operating mode,
(ii) the propagation constant $\gamma$
(iii) the intrinsic impedance $\eta$. **[05 Marks]**

(b) Explain the Smith Chart in detail and write about its distributed elements applications and advantages. **[05 Marks]**

**[Total = 10 Marks]**