International Islamic University Chittagong (IIUC)

Department of Electronic and Telecommunication Engineering

Final Examination

Program: **B.sc (Engg.)**
Course Code: **ETE-3507**
Total Marks: **50**

Semester: **Spring 2022**
Course Title: **Electromagnetic Fields and Waves**
Time: **2 Hours 30 Minutes**

(i) Answer all the questions. The figures in the right-hand margin indicate full marks.
(ii) Course Outcomes (COs) and Bloom's Levels are mentioned in additional Columns.

Course Outcomes (COs) of the Questions	
CLO1	Understand and analyze the basic concepts related to Electrostatics, Magnetostatics and Electromagnetic Waves.
CLO2	Determine Electric and Magnetic Field for different scenarios with varying specifications using different techniques.
CLO3	Analyze propagation of Electromagnetic Waves in different mediums using Maxwell's Equations.

Bloom's Levels of the Questions						
Letter Symbols	**R**	**U**	**Ap**	**An**	**E**	**C**
Meaning	Remember	Understand	Apply	Analyze	Evaluate	Create

PART A					
Q1.	**a)**	Write down the Maxwell's equations for time varying fields and express their meaning.	**CLO1**	**U**	**2**
	b)	Show that, the 1st and 2nd Maxwell's equations are derived from Ampere's circuital law and Faraday's laws respectively.	**CLO2**	**An**	**6**
	c)	Verify whether the following fields $E = 2\sin x \sin t \; a_y$ and $H = \frac{2}{\mu_0}\cos x \cos t \; a_z$, satisfy Maxwell's equations in free space.	**CLO2**	**Ap**	**2**
Q2.	**a)**	What is the condition of an EM wave propagating along x-direction?	**CLO1**	**U**	**1**
	b)	Derive the EM wave equations for a conducting medium.	**CLO2**	**Ap**	**4**
	c)	Derive the condition for **E** and **H** fields of EM wave being perpendicular to each other.	**CLO2**	**An**	**2**
	d)	Identify frequency, phase constant when the electric field of an EM wave is given by $E = 4.0\sin(10^7 t - 4.0\,x)\; a_z$. Also find λ.	**CLO3**	**An**	**3**
OR					
Q2.	**a)**	Illustrate your idea on "attenuation constant".	**CLO1**	**U**	**2**
	b)	Derive the equation for attenuation constant of EM wave in conducting medium.	**CLO2**	**An**	**6**
	c)	Estimate the depth of penetration, δ of an EM wave in copper at $f = 500\ MHz$. For copper, $\sigma = 5.8 \times 10^7\ mho/m$, $\mu_r = 1$ and $\epsilon_r = 1$.	**CLO2**	**Ap**	**2**
PART B					
Q3.	**a)**	Illustrate on reflection and transmission coefficients of EM waves.	**CLO1**	**R**	**2**
	b)	Derive the expressions for the reflection and transmission coefficients of both E and H fields.	**CLO2**	**An**	**6**

	c)	The magnetic field, **H** of a plane EM wave has a magnitude of 5.5 mA/m in a medium defined by $\epsilon_r = 4$, $\mu_r = 1$. Determine the average power flow in the plane wave.	CLO2	Ap	2
Q4.	a)	Compose the conditions of E, D, H and B fields at the boundary surface of two different media.	CLO1	U	4
	b)	Prove that the tangential components of **E** at the surface of boundary between two media are equal.	CLO2	U	3
	c)	The region $y < 0$ contains a dielectric material for which $\epsilon_{r1} = 2.0$ and the region $y > 0$ contains a dielectric material for which $\epsilon_{r2} = 4.0$. If $E_1 = -3.0\,a_x + 5.0\,a_y + 7.0a_z$ V/m, find the electric field E_2 and D_2 in medium 2.	CLO3	An	3
Q5.	a)	Explain your idea on "transmission lines".	CLO1	U	2
	b)	Derive the relation $\rho \equiv \frac{Z_L - Z_0}{Z_L + Z_0}$, where the symbols have their usual meaning.	CLO2	An	8
		OR			
Q5.	a)	For a particular frequency, how do we determine whether a medium is a dielectric or a conductor?	CLO1	U	2
	b)	Prove that AC resistance is far greater than DC resistance in higher frequencies. For a transmission line which is terminated in a normalised impedance Z_n, VSWR = 4. Find the normalised impedance magnitude.	CLO2	An	8