Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

FOURTH SEMESTER BTECH. (E & C) DEGREE END SEMESTER EXAMINATION

JUNE 2022

SUBJECT: ELECTROMAGNETIC WAVES (ECE -2252)

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to candidates

- Answer **ALL** questions.
- Missing data may be suitably assumed.

Q. No.	Questions	M*	C*	A*	B*
1A.	Derive an expression for divergence using Gauss's Law. Show all intermediate steps.	4	1	1,2,3,4,18	3
1B.	The spherical region, 0 < r < 10 cm, contains a uniform volume charge density of 4μC/m^3. (i) Find Q_{tot}, 0 < r < 10 cm (ii) Find D_r, 0 < r < 10 cm (iii) The uniform volume charge density, $\rho_v = -3/(r^3 + 0.001)$ nC/m^3, exists for 10 cm < r < r_0. Find r_0 so that the total charge in the region 0 < r < r_0 is zero	3	1	1,2,3,4,18	4
1C.	If $\overline{G} = 5\, r\sin^2\theta\cos^2\phi\, \overline{a_r}$, evaluate both sides of the divergence theorem for the region $r \leq 2$. Show all intermediate steps.	3	1	1,2,3,4,18	4
2A.	Two extensive homogeneous isotropic dielectrics meet on plane z = 0. For z > 0, $\varepsilon_{r1} = 4$ and for z < 0, $\varepsilon_{r2} = 3$. A uniform electric field $\mathbf{E_1} = 5\mathbf{a_x} - 2\mathbf{a_y} + 3\mathbf{a_z}$ kV/m exists for z ≥ 0. Find (i) $\mathbf{E_2}$ for z ≤ 0 (ii) The angles E_1 and E_2 make with the interface (iii) The energy densities (in J/m^3) in both dielectrics (iv) The energy within a cube of side 2 m centered at (3, 4, -5)	4	1	1,2,3,4,18	4
2B.	Given the electrical potential $V = \frac{10}{r^2}\sin\theta\cos\phi$, (i) Find the electric flux density **D** at (2, π/2, 0). (ii) Calculate the work done in moving a 10 μC charge from point A(l, 30°, 120°) to B(4, 90°, 60°).	3	1	1,2,3,4,18	4

2C.	Sketch the magnitudes of voltage and current for two wavelengths, on a dissipation less two wire transmission line when: (i) Load impedance is equal to zero (ii)Load impedance is equal to infinity (iii) load impedance is equal to characteristic impedance	3	4	1,2,3,4,18	3
3A.	Write the mathematical expression equating left hand side and right hand side of Stoke's theorem and explain each sides.	2	1	1,2,3,4,18	2
3B.	State and prove Vector Poynting theorem	3	2	1,2,4,18	2
3C.	A 9375 MHz uniform plane wave is propagating in polystyrene. If electric filed intensity is 20 V/m and material is assumed to be lossless, find (a) Phase constant β (b) Wavelength λ (c) Wave phase velocity (velocity of propagation) v_p (d) Intrinsic impedance η (e) Propagation constant k (f) Magnetic field intensity H For polystyrene relative permittivity is 2.56 and relative permeability is 1.	5	2	1,2,4,18	4
4A.	Find the amplitude of displacement current density in metallic conductor at 60Hz if $\varepsilon = \varepsilon_0$, $\mu = \mu_0$, $\sigma = 5.8 \times 10^7$ S/m and $J = \sin(377t - 117.1z)10^6 \mathbf{a_x}$ A/m^2.	2	2	1,2,4,18	4
4B.	Obtain the Maxwell's equations from Faraday's law of electromagnetic induction.	3	2	1,2,4,18	3
4C.	From fundamentals derive complete expressions for voltage and current at any point on a dissipation less two wire transmission line in trigonometric form.	5	4	1,2,3,4,18	3
5A.	At a frequency of 1GHz the characteristic impedance and propagation constant of a two wire transmission line are (179.44+j26.5)Ω and (0.051+j0.273)/m respectively. Determine the primary parameters of the transmission line.	2	4	1,2,3,4,18	4
5B.	A 50 Ohm lossless line connects a signal of 100KHz to a load of 100Ω. The load power is 100 mW. Calculate the (i) Voltage reflection coefficient (ii)VSWR (iii) Position of first V_{min} and V_{max}. (iv) Impedance at V_{min} and V_{max} and the values of V_{min} and V_{max}.	4	4	1,2,3,4,18	4

5C.	A load impedance of (73-j80)Ω is required to be matched to a 50Ω coaxial line having lossless dielectric with $\varepsilon_r = 4$, using a 50Ω short circuit shunt stub at 500 MHz. Determine the length and position of the inductive stub using Smith chart.	4	4	1,2,3,4,18	4

M*--Marks, C*--CLO, A*--AHEP LO, B* Blooms Taxonomy Level