EC303 APPLIED ELECTROMAGNETIC THEORY

UNIVERSITY QUESTION PAPER

MODULE 1

1. State and prove Ampere's circuit law and coulomb's law**(KTU, May 2019,Apr2018, Sept 2020)** (6)
2. Explain Scalar and vector magnetic potential **(KTU, Dec 2019)** (7)
3. State and explain Gauss Law **(KTU, Dec 2019)** (5)
4. Derive an expression for magnetic energy of a continuous distribution of current in a volume. **(KTU,May2019, Sept 2020)** (7)

5. Find the potential function and electric field intensity for the region between concentric right circular cylinders, where V = 0 at r = 1 mm and V = 100 V at r = 30 mm. **(KTU, May 2019)** (5)

6. A square loop of 4m side is placed in *xy*- plane with its centre at the origin and sides long the coordinates axes. If the magnetic flux density in the region is givenby $B = (0.28a_x - 0.3a_y + 0.4a_z)^{-0.1t}\ Wb/m^2$, find the induced EMF in the loop at t=10s. **(KTU,May2019)** (8)

7. An air filled parallel plate capacitor is with following specification, area = 2 m^2 and spacing between the plates = 0.l m. If a voltage = $20cos10^3t$ is applied across the capacitor plates, find the magnetic field between the capacitor plates. **(KTU,May2019)** (5)

8. Point charges 5 nC and -2 nC are located at (2, 0, 4) and (-3, 0, 5), respectively.
(i) Determine the force on a 1nC point charge located at (1, -3, 7).
(ii) Find the electric field E at (1, - 3, 7). **(KTU,Dec2018)** (7)

9. Give Poisson's and Laplace equation in electrostatics. Give application. **(KTU, Dec 2018)**(7)
10. Derive the expression of capacitance and inductance of two wire transmission line. **(KTU, Dec 2019, Dec 2018,Dec2017)** (8)
11. Define electric field intensity. Derive the equation for electric field intensity at a distance '*r*' from a point charge of *Q* coulombs. **(KTU,Apr2018)** (7)

12. Define curl of a vector field. Derive the equation for curl of a vector field in Cartesian co-ordinate system. **(KTU,Apr2018)** (10)

13. Derive the expressions for Energy stored in Electric Field. **(KTU,Dec2017)** (8)

14. Eight identical charges, *Q* each are placed on the corners of a cube of side '*a*'. Find the resultant force on a charge. **(KTU,Dec2017)** (7)

MODULE 2

1. State and explain Maxwell's equations in the integral and differential forms. **(KTU, Dec 2019, May 2019, Dec 2018,Dec2017)** (8)

2. Derive the solution of uniform plane wave in lossy dielectric medium.**(KTU,May2019)**(6)

3. State and prove boundary conditions for E and H in accordance with Maxwell's equations. **(KTU, Dec 2018,Dec2017, Sept 2020)** (7)

4. Starting from Maxwell equation, derive the wave equation for a conducting medium. **(KTU, Apr 2018,Dec2017)** (7)

5. Derive the equation for Electric and Magnetic field intensities for an electromagnetic wave propagating in the z-direction in a dielectric medium.
   $H=10e^{-\alpha x}\cos(wt-0.5x)a_z$ A/m., impedance of medium is 173+j100Ω
   Find the following:
   i) Attenuation constant; ii)Phase velocity; iii)Phase constant; iv)Intrinsic impedance. v)Direction of Propagation, vi) Loss tangent, vii) Skin depth
   (KTU,Apr2018, Sept 2020)(9)

6. Define skin depth for a conductive medium? If σ denotes the conductivity, Derive the equation for skin depth for a good conductor. **(KTU,Apr2018, Sept2020)** (5)

7. Derive the boundary conditions for electric field at the interface of two dielectrics. **(KTU, Dec2017)** (6)

8. Explain Group velocity and Phase velocity. When a wave of 6 GHz propagates in parallel conducting plates separated by 3 cm, find the $V_p$and V_g of the wave for dominant wave.**(KTU,Dec2017)** (8)

MODULE 3

1. Derive an expression for reflection coefficient of a plane wave incidence with parallel polarization(or perpendicular polarization) at a dielectric interface. **(KTU,Dec 2019, May2019, Sept 2020)** (5)

2. Derive an expression for net outward power flow associated with anelectromagnetic wave, from a surface. **(KTU,May2019)** (10)

3. What is Snell's law? **(KTU,May2019)** (3)

4. What is Polarisation? Explain the different types of Polarisation? **(KTU, Dec2018, Dec2017, Sept 2020)** (7)

5. Derive the expression for the ratio of reflected to incident electric field strength for an insulator with oblique incidence. **(KTU,Dec2018)** (7.5)

6. Derive the expression for refraction and reflection coefficient of plane electromagnetic waves that undergoing oblique incidence with vertical polarization (considering boundary separation). **(KTU,Apr2018)** (7)

7. State Poynting theorem. Derive the equation of complex vector. **(KTU,Dec2017)** (8)

8. Derive Brewster angle. A parallel-polarized plane wave is incident from air onto a dielectric medium with $\varepsilon_r = 9$ at the Brewster angle. What is the refractionangle? **(KTU,Dec2017, Sept 2020)** (9)

MODULE 4

1. Define reflection coefficient and VSWR of a transmission line and derive the relation between reflection coefficient and VSWR. **(KTU, May 2019,Dec2018)** (7)

2. Derive the current and voltage equation of a transmission line. **(KTU,May2019)** (7)

3. Draw the circuit of small section of transmission line of differential length and label the circuit parameters. **(KTU,May2019)** (3)

4. AlosslesstransmissionlinehasprimaryconstantL=0.01μH/m,C=100pF/m.Find the characteristic impedance or the line. **(KTU,May2019)** (5)

5. Deriveanexpressionforcharacteristicimpedanceofatransmissionlineandshowthat it is resistive at radio frequencies. **(KTU,Dec2018)** (7)

6. Derive the ABCD parameters of a transmission line. **(KTU,Dec2017)** (8)

7. A lossless 50-Ω transmission line is terminated in a load with ZL = (50+ j25) Ω. Calculate(i)ThereflectioncoefficientΓ.(ii)Thestanding-waveratio.**(KTU,Dec2017, Sept 2020)** (7)

8. Derive standard Transmission line equations. **(KTU,Dec2017)** (6)

9. Derive the equation of input impedance of a transmission line due to line terminated by a load **(KTU, Dec 2019)** **(7)**
10. Derive the expression for characteristic impedance of a transmission line **(KTU, Dec 2019) (8)**

MODULE 5

1. What are distributed elements? **(KTU,May2019)** (4)

2. A load impedance 90 - j25 is to be matched to 50 Ω using single stub matching. Find the length and location of stub using smith chart. **(KTU,May2019)** (10)

3. Derive the expression for r-circles and x-circles in Smith chart. **(KTU,Dec 2018, Sept 2020)** (10)

4. Explain single stub matching using analytical method. **(KTU, Dec 2019, Dec2018)** (10)

5. Write short notes on single stub matching and double stub matching. **(KTU,Apr2018)** (8)

6. How a smith chart is useful in finding the stub length for impedance matching. **(KTU, Apr2018)** (4)

7. Write note on half wave and quarter wave transmission lines. **(KTU,Dec2017, Sept 2020)** (5)

8. A lossless 60Ω line is terminated by a 60 + j60Ω load. Find Γ, s, load admittance, Reflection coefficient at 0.2λ from the load if Z_{in} = 120 - j60 Ω. How far is the load from generator (Solve with Smith chart)? **(KTU,Dec 2017,Sept 2020)** (6)

9. Design a stub to match 40 + j30 Ω load (antenna) to a lossless line of 100 Ω (use Smith chart). **(KTU,Dec2017)** (9)

10. By analytical method, get the value of position where stub has to be placed from load and stub length with single stub impedance matching in transmission lines. **(KTU, Dec 2019,Dec2017, Sept 2020)** (7)

11. Explain Half Wave and Quarter Wave Transmission lines. Given that Z_L = 30 + j40 Ω, Z0 = 50 Ω. Find the shortest length ('*l*') and point where stub has to be placed for a matching. (Use Smith chart) **(KTU,Dec2017)** (10)

MODULE 6

1. Derive the expressions for TE(or TM) mode in a rectangular wave guide. **(KTU, Dec 2019, May 2019, Apr 2018, Sept 2020)** (10)

2. The longitudinal electric field for TM_{11} mode is givenby
$E_z = \sin 5x \sin 8y\, e^{-j\beta z}\, V/m$. Find the cut off frequency of the mode. **(KTU, May 2019)** (7)

3 The cross section of a rectangular wave guide is 20 cm x 5 cm. Find 3 lowest order mode frequencies. **(KTU,May2019)** (3)

4 Determine, assuming TE_{10} mode of propagation ,the cut-off frequency, cut-off wavelength, guide wavelength, phase constant, phase velocity, group velocity and wave impedanceinthecaseofahollowrectangularmetallicwaveguideofdimensions6cm and 3 cm, respectively, when the applied signal frequency is 5 GHz. **(KTU, Dec 2018, Sept 2020)** (10)

5 A hollow rectangular waveguide has dimensions of a= 4 cm and b= 2 cm. Calculate the amount of attenuation if the frequency is 3.5 GHz. Assume dominant mode. **(KTU, Dec 2018)** (10)

6 With a neat diagram explain the propagation of electromagnetic wave in a rectangular wave guide? **(KTU,Dec 2019, Apr 2018)** (8)

7 What are called degenerate modes? Explain. **(KTU,Dec2017)** (5)

8 Draw the field distribution pattern for TE_{20} mode inside a rectangular waveguide. **(KTU, Dec2017)** (4)

9 List all the modes which are supported in rectangular waveguides and why? **(KTU, Dec 2017)** (8)

10 Derive the relationship between guide wavelength, free space wavelength and cut off wavelength in rectangular waveguide. **(KTU,Dec 2017)** (5)

11 Discuss the attenuation of waveguides. **(KTU,Dec2017)** (5)

12 Explain waveguides and its different modes of wave propagation. **(KTU,Dec2017)** (10)