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 **PRESIDENCY UNIVERSITY**

  **Bengaluru**

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| **End - Term Examinations – JANUARY 2025** |
| **Date:** 10 – 01- 2025 **Time:** 09:30 am – 12:30 pm |

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| **School:** SOE | **Program:** B. Tech ECE |
| **Course Code :** ECE3009 | **Course Name :** Transmission Line and Waveguide |
| **Semester**: V | **Max Marks**: 100 | **Weightage**: 50% |

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| **CO - Levels** | **CO1** | **CO2** | **CO3** | **CO4** | **CO5** |
| **Marks** | **21** | **9** | **69** | **NA** | **NA** |

**Instructions:**

1. *Read all questions carefully and answer accordingly.*
2. *Do not write anything on the question paper other than roll number.*

**Part A**

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| **Answer ALL the Questions. Each question carries 2marks. 10Q x 2M=20M** |
| **1** | Transmission line is a mechanism that is used to send and/or receive power or signals from one location to another. Mention the main drawback of two-wire transmission line and how do you overcome this drawback? | **2 Marks** | **L1** | **CO1** |
| **2** | Phase velocity is the speed at which a wave at constant phase travels along the transmission line. Relate phase velocity in terms of angular frequency and phase constant. What is the phase velocity for a distortion less transmission line?  | **2 Marks** | **L1** | **CO1** |
| **3** | In the transmission line what if the load impedance (ZL) is not matching with the characteristic impedance (ZO), mention at least one drawback due to mismatch. Mention any one of the impedance matching technique to overcome the drawback? | **2 Marks** | **L1** | **CO1** |
| **4** | Waveguide is a hallow metallic tube that is used to transfer electromagnetic (EM) energy from one point to another. Mention at least two important reasons why waveguide is used in place of transmission line | **2 Marks** | **L1** | **CO3** |
| **5** | Let us assume that a rectangular waveguide is filled with source free loss less dielectric material and the walls are made of perfect single metallic conductor. Mention the properties/characteristics of source free loss less dielectric material and perfect single metallic conductor? | **2 Marks** | **L1** | **CO3** |
| **6** | The boundary conditions for a rectangular waveguide are obtained from the requirement that, the tangential components of the electric field be continuous at the walls of the waveguide. Mention the boundary conditions for all the walls of the rectangular waveguide? | **2 Marks** | **L1** | **CO3** |
| **7** | Cavity resonator is a hallow metallic tube shorted at both ends exhibit resonance behavior when excited by electromagnetic field. Mention why cavity resonators are used in place of RLC resonant circuits at high frequencies? | **2 Marks** | **L1** | **CO3** |
| **8** | Bessel functions are used to solve any difficult second order differential equations in cylindrical coordinate systems. Hence, these functions are used to determine field components of electromagnetic waves in circular waveguide. Write an expression for Bessel function of first kind. | **2 Marks** | **L1** | **CO3** |
| **9** | In circular waveguide, mention the dominant modes for TEmn and TMmn modes?  | **2 Marks** | **L1** | **CO3** |
| **10** | Apart from physical structure and dimensions, how do you compare circular waveguide with rectangular waveguide?  | **2 Marks** | **L1** | **CO3** |

**Part B**

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| **Answer the Questions Total 80 Marks** |
| **11.** |  | A rectangular waveguide is designed to operate below 12GHz with a dimensions a=2.5cm and b=1cm. If the waveguide is filled with dielectric medium characterized by $σ=0, ϵ=4ϵ\_{0}, μ\_{r}=1$ determine various TE and TM modes and calculate cutoff frequency for each mode? | **10****Marks** | **L3** | **CO3** |
| **or** |
| **12.** |  | An air-filled rectangular waveguide operates at 30 GHz. If the cutoff frequency of the TE13 mode is 20 GHz, calculate the wavelength, phase constant, phase velocity, and intrinsic impedance of this mode. | **10****Marks** | **L2** | **CO3** |
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| **13.** |  | A lossless transmission line, with characteristic impedance of $60 Ω$ and electrical length of $l=0.35 λ$, is terminated by a load impedance $25-j40 Ω$. Determine $Γ$, S, and Zin using Smith Chart? | **10****Marks** | **L3** | **CO2** |
| **or** |
| **14.** |  | A $50 Ω$ lossless transmission line of 10 m long is terminated by a $100+j120 Ω$ load. To perfectly match, what should be the length and location of a short-circuited stub line? Assume an operating frequency of 100 MHz. Use Smith chart. | **10****Marks** | **L3** | **CO2** |

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| **15.** |  | Rectangular cavity resonators are metal boxes that are hollow and rectangular. They trap electromagnetic waves by reflecting them back and forth between their limits. Derive an expression for resonant frequency and quality factor for a rectangular cavity resonator? | **10****Marks** | **L2** | **CO3** |
| **Or** |
| **16.** |  | A circular cavity resonator is a metallic box that retains electromagnetic energy as electric and magnetic fields. It is made by placing conducting sheets on both ends of a circular waveguide to form a cavity inside the waveguide. Derive an expression for resonant frequency (fr\_nml) for TEnml and TMnml modes? | **10****Marks** | **L2** | **CO3** |

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| **17.** |  | Derive the expressions for field components of TE mode in circular waveguide? Determine J1(x) and J2(x) for x = 2, 3 using Bessel function of first kind? | **15****Marks** | **L3** | **CO2** |
| **Or** |
| **18.** |  | Derive the expressions for field components of TM mode in circular waveguide? An air filled circular waveguide has a radius of 3 cm is excited in dominant mode at 9 GHz. Determine its cutoff frequency and guide wavelength? | **15****Marks** | **L3** | **CO2** |

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| **19.** |  | Derive an expression for characteristic impedance of a general transmission line. From the above, find an expression for characteristic impedance of lossless transmission line in terms of L and C and for distortionless transmission line in terms of R and G? A transmission line has a characteristic impedance of $50Ω$, maximum voltage of 2.5V and a minimum voltage of 1V. Determine (i) VSWR (ii) ZL | **15****Marks** | **L3** | **CO1** |
| **Or** |
| **20.** |  | Derive an expression for reflection coefficient ($Γ$) and transmission coefficient (T) in terms of load impedance (ZL) and characteristic impedance (ZO) of the transmission line?The transmission line has inductive reactance of $17.8 Ω$ and capacitive reactance of $47.5 Ω$ is operated at 100MHz frequency. Find attenuation constant ($α$) and phase constant ($β$) of the transmission line? | **15****Marks** | **L3** | **CO1** |

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| **21.** |  | Find the formulas for the TE mode's field components in a rectangular waveguide. In a rectangular waveguide for which $a=2.8cm, b=1.5cm, σ=0, μ=μ\_{0}, and ϵ=4ϵ\_{0}.$ The magnetic field along x-axis is $H\_{x}=3sin\left(\frac{πx}{a}\right)cos\left(\frac{3πy}{b}\right)sin\left(π×10^{10}t-βZ\right) A/m$. Determine (i)Mode of operation (ii) Phase constant | **20****Marks** | **L3** | **CO3** |
| **Or** |
| **22.** |  | Derive the expressions for cut-off frequency, phase constant and guide wavelength of rectangular waveguide?An air-filled rectangular waveguide of dimension 5 cm X 3 cm operates on the TE10 mode at a frequency of 10.5 GHz. Find the phase constant, phase velocity, and the wave impedance. | **20****Marks** | **L3** | **CO3** |

**\*\*\*\*\* BEST WISHES \*\*\*\*\***