Total No. of printed pages = 4

ECE 181701

Roll No. of candidate

2022

B.Tech. 7th Semester End-Term Examination

ECE + ETE

MICROWAVE ENGINEERING – I

(New Regulation (w.e.f. 2017-18) & New Syllabus (w.e.f. 2018-19))

Full Marks – 70   Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer Question No. 1 and any *Four* from the rest.

1.   Choose the correct answer: $(10 \times 1 = 10)$

   (i)   In a lossless line, the phase velocity is 2.5×10^8 m/s. If the characteristic impedance of the line is 50 Ω, the inductance per unit length of the line in (nH/m) is

      (a)   30

      (b)   50

      (c)   100

      (d)   200

   (ii) If the Characteristic Impedance of a transmission line is real, the line has to be a lossless line

      (a)   True

      (b)   False

      (c)   Can't Say

      (d)   Neither

   (iii) For a rectangular waveguide having internal dimensions $a \times b$ and $a = \sqrt{3}\, b$, the cutoff frequency of TM_{11} mode is same as TE_{20} mode

      (a)   True

   (b)   False

      (c)   Can't Say

      (d)   Neither

[Turn over

(iv) A two port network having the scattering matrix $\begin{bmatrix} 0.8 < 0° & 0.6 < 45° \\ 0.6 < 45° & 0.6 < 0° \end{bmatrix}$

    (a) Lossless and reciprocal

    (b) Lossless but not reciprocal

    (c) Reciprocal but not lossless

    (d) Neither reciprocal nor lossless

(v) A lossless transmission line of characteristic impedance Z_0 is terminated to a load impedance of $60 + j80\ \Omega$. The value of Z_0 for which the VSWR on this line is minimum is

    (a) $50\ \Omega$

    (b) $75\ \Omega$

    (c) $100\ \Omega$

    (d) $125\ \Omega$

(vi) The length of an exponential taper section used for designing a matching network is kept greater than $\lambda/2$ to minimize the mismatch at low frequencies

    (a) True

    (b) False

    (c) Can't Say

    (d) Neither

(vii) What is the frequency range of Microwave?

    (a) 3kHz-300Ghz

    (b) 300MHz-300GHz

    (c) 300MHz-3000MHz

    (d) 3KHz-30KHz

(viii) Which of the following devices can't be used as Microwave Oscillator

    (a) IMPATT Diode

    (b) PN Junction Diode

    (c) TRAPATT Diode

    (d) BARITT Diode

(ix) S parameters are expressed as a ratio of:

    (a) Voltage and current

    (b) Impedance at different ports

    (c) Indecent and the reflected voltage waves

    (d) None of the mentioned

(x) Scattering matrix for a reciprocal network is:

    (a) Symmetric

    (b) Unitary

    (c) Skew symmetric

    (d) Identity matrix

2. (a) Write the applications of Microwave. (3)

   (b) What is Reflection Co-efficient? Derive the expression for Complex Propagation Constant, Characteristic Impedance and Wavelength for a Wave Propagation in a Transmission Line if the nature of propagation is considered Lossless? (7)

   (c) A 300-Ω lossless air transmission line is connected to a complex load composed of a resistor in series with an inductor shown in figure below. At 5 MHz, determine: (5)
   (i) Reflection Co-efficient (Γ)
   (ii) Standing Wave Ratio (ρ).

$Z_0 = 300\ \Omega$

$R = 600\ \Omega$

$L = 0.02$ mH
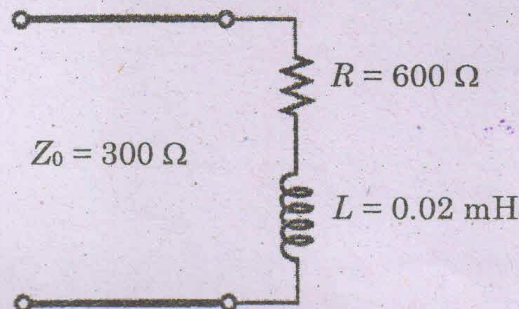
3. (a) Derive the field equation for TM Mode in Rectangular Waveguide starting from Maxwell's equations. (7)

   (b) Define the phase and group velocity. (3)

   (c) An air-filled circular waveguide is to be operated at frequency of 5.5 GHz and is to have dimension such that the cut-off frequency (f_c) = 0.8f for the dominant mode. Determine (i) The diameter of the guide. (ii) The wavelength λ_g and phase velocity v_g in the guide. (5)

4. (a) Why Z and Y parameters are not measured at microwave frequency. (2)

   (b) Derive an expression for Power Flow at the n-th port of a two port microwave network? (5)

   (c) Describe the working of a Directional Coupler with proper diagram and S-matrix representation? Explain the two important characteristics of a Directional Coupler. (8)

5. (a) Explain the physical structure of an IMPATT Diode. What do you understand by negative resistance of an IMPATT diode, explain with suitable diagram? (3+3=6)

   (b) What is a Magnetron Oscillator? Describe in brief the different types of Magnetrons? Derive the Hull cut-off condition. (2+4+3=9)

6. (a) Describe how can the power of a microwave generator be measured using:

    (i) Bolometer   (5+5=10)

    (ii) Calorimeter techniques

(b) What is a Low Noise Amplifier? What are the characteristics for designing a Low Noise Amplifier?   (2+3=5)

7. Write short notes on (any three)   (3×5=15)

    (a) Gunn Diode

    (b) Magic Tee

    (c) Travelling Wave Tube (TWT)

    (d) Microwave Antennas for Radar Communication

    (e) Reflex Klystron

    (f) Microwave Circulator

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