

Registration No.:

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Total Number of Pages: 02

Course: B.Tech/IDD
Sub_Code: REC6C001

6th Semester Regular Examination: 2024-25

SUBJECT: Microwave Engineering

BRANCH(S): ECE, ETC

Time: 3 Hours

Max Marks: 100

Q.Code: S088

Answer Question No.1 (Part-1) which is compulsory, any eight from Part-II and any two from Part-III.

The figures in the right hand margin indicate marks. Students will be provided with the Smith chart for Question No. 3 (a) and 3(b)

Part-I

Q1 Answer the following questions: (2 x 10)

- Define the term VSWR and find its relation with reflection coefficient.
- Find the reflection coefficient of a transmission line having a characteristics impedance of $50 + j0.01\Omega$ and is terminated with a load impedance of $73 - j42.5\Omega$.
- Define the parameters R, L, C, and G of a transmission line and write the transmission line equation.
- What is the dominant mode in a rectangular waveguide and Why TEM mode is not supported in rectangular waveguides?
- Differentiate between fixed and variable attenuators.
- What is the Q-factor of a microwave resonator?
- What is meant by the excitation of a waveguide cavity?
- What is the role of the carrier amplifier in a Doherty amplifier configuration?
- List different methods of impedance measurement at microwave frequency.
- Why parabolic reflector antenna is popularly used for long distance communication?

Part-II

Q2 Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve) (6 x 8)

- An air-filled waveguide has a cross section of $2.4 \text{ cm} \times 1.2 \text{ cm}$. A microwave signal of 12 GHz propagates down the guide. (I) Calculate the cutoff frequencies of TE₁₀, TE₀₁, TE₂₀, and TE₀₂ modes. (II) Which modes will propagate?
- Discuss the limitations of single stub matching and how they are taken care? Explain the concept of double stub matching.
- What will be the characteristic impedance and propagation constant of a telephone line having $R = 30 \Omega/\text{Km}$, $L = 100 \text{ mH}/\text{Km}$, $G = 0$ and $C = 20 \mu\text{F}/\text{Km}$ at $f = 1 \text{ KHz}$.
- Why impedance matching is required? Classify the techniques of impedance matching and discuss in details
- Design a cylindrical waveguide to support only the dominant TE₁₁ mode for operation at 8 GHz.

- f) Define and derive the resonant condition for a cavity resonator. Discuss how boundary conditions lead to discrete resonant frequencies.
- g) Derive the transmission line parameters (R, L, G, and C) of a Coaxial line in terms of electric field and magnetic field.
- h) What is Faraday rotation? How is it used in the design of a Faraday isolator? Explain the construction and working of such an isolator with field orientation diagrams.
- i) The IS-54 digital cellular telephone system uses a receive frequency band of 869 - 894 MHz, with a first IF frequency of 87 MHz and a channel bandwidth of 30 kHz. What are the two possible ranges for the LO frequency? If the upper LO frequency range is used, determine the image frequency range. Does the image frequency fall within the receive passband?
- j) Explain the working principle of variable precision attenuator.
- k) A 20-dBm power source is connected to the input of a directional coupler having a coupling factor of 20 dB, a directivity of 35 dB, and an insertion loss of 0.5 dB. If all ports are matched, find the output powers (in dBm) at the through, coupled, and isolated ports.
- l) Explain "Radiation pattern of any antenna and its measurement".

Part-III

Only Long Answer Type Questions (Answer Any Two out of Four)

(16 x 2)

- Q3** a) A lossless transmission line with $Z_0 = 50\Omega$ is 30 m long and operates at 2 MHz. The line is terminated with a load $Z_L = 60 + j40 \Omega$. If $u = 0.6c$ on the line. find the following parameters with the help of smith chart (i) The reflection coefficient Γ (ii) The standing wave ratio s (iii) The input impedance (10 + 6)
- b) A load impedance $90 - j25 \Omega$ is to be matched to 50Ω using single stub matching. Find the length and location of the stub with the help of smith chart.
- Q4** a) Describe the working principle of a Gunn Oscillator. (8 + 8)
- b) Describe the working principle of a High Electron Mobility Transistor (HEMT).
- Q5** a) Design an equally split Wilkinson Power divider circuit by Even-Odd mode analysis and establish the S-parameters. (10 + 6)
- b) A lossless T-junction power divider has a source impedance of 50Ω . Find the output characteristic impedances so that the output powers are in a 2:1 ratio. Compute the reflection coefficients seen looking into the output ports.
- Q6** a) A pyramidal horn antenna is designed to operate at a frequency of 15 GHz. The aperture dimensions of the horn are $a = 12$ cm and $b = 9$ cm. Assume the aperture efficiency $\eta_a = 0.65$ (10 + 6)
- i. Determine the effective aperture area of the horn.
 - ii. Calculate the gain of the horn antenna in both linear and dBi terms.
 - iii. Estimate the half-power beam widths (HPBW) in both E-plane and H- plane using empirical formulas.
- b) Describe different types of attenuation of microwaves in ionosphere.