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Sixth Semester B.E. Degree Examination, Jan./Feb. 2021

Microwaves and Radar

Time: 3 hrs.

Max. Marks:100

- Note:** 1. Answer any FIVE full questions, selecting at least TWO questions from each part.
2. Use of Smith chart is permitted.

PART – A

1. a. By considering elementary section of transmission line, derive transmission line equations. (08 Marks)
b. Define transmission coefficient and derive an expression for transmission coefficient in terms of characteristic impedance ' z_0 ' and load impedance ' z_c '. (06 Marks)
c. A load impedance of $73 - j80\Omega$ is required to be matched to a 50Ω co-axial line having operating wavelength of $\lambda = 30$ cm. Using a short circuited shunt stub, determine the position 'd' and length ' l ' of the stub. (06 Marks)
2. a. An air filled rectangular waveguide of inside diameter $a = 7$ cm and $b = 3.5$ cm operates in the dominant TE_{10} mode. Find:
(i) The cutoff frequency
(ii) The phase velocity of the wave in the guide at a frequency of 3.5 GHz
(iii) The guide wavelength at the same frequency. (06 Marks)
b. Explain the basic principle of operation of Four-Port circulator. (06 Marks)
c. With a neat diagram, explain the working of a two-hole directional coupler. Also derive the scattering matrix of the same. (08 Marks)
3. a. Draw a schematic diagram of n-type GaAs diode, and explain its operations. (08 Marks)
b. Explain the principle of operation of READ diode with suitable diagram. (08 Marks)
c. An IMPATT diode has the following parameters:
Carrier drift velocity, $V_d = 2 \times 10^7$ cm/s
Drift region length, $L = 6 \mu\text{m}$
Maximum operating voltage, $V_{0\text{max}} = 100$ v
Maximum operating current, $I_{0\text{max}} = 200$ mA
Efficiency, $\eta = 15\%$
Breakdown voltage, $V_{\text{bd}} = 90$ V
Calculate: (i) The maximum CW output power in Watts
(ii) The resonant frequency in GHz. (04 Marks)
4. a. State and derive properties of S - parameters. (10 Marks)
b. Define Insertion loss, Transmission loss and Return loss in terms of S – parameters. (06 Marks)
c. What are the advantages of S – matrices over Z – matrices? (04 Marks)

PART – B

5. a. With a neat sketch, explain the operation of E – plane Tee and Also obtain its S – matrix. (08 Marks)
b. With a neat diagram, explain the construction and operation of precision type variable attenuator. (06 Marks)
c. A 20 MW signal is fed into a collinear port say port-1 of a lossless H-plane Tee junction. Calculate the power delivered through each port with other ports are terminated in matched load. (06 Marks)

- 6 a. Briefly explain the dielectric losses and radiation losses in a microstripline. (08 Marks)
- b. A lossless parallel stripline has a conducting strip width 'w', the substrate dielectric separating the two conducting strips has a relative dielectric constant ' ϵ_{rd} ' of 6 and a thickness 'd' of 4 mm. Calculate:
- The required width 'w' of the conducting strip in order to have a characteristic impedance of 50Ω .
 - The stripline capacitance
 - The stripline inductance (06 Marks)
- c. Write short note on Shielded strip lines. (06 Marks)
- 7 a. Derive the simple radar range equation starting from power density of an isotropic antenna. (06 Marks)
- b. With a neat block diagram, explain the conventional pulse radar with a superhetrodyne receiver. (08 Marks)
- c. A ground based Air Surveillance radar operates at a frequency of 1.3 GHz. Its maximum range is 200 nmi for the detection of a target with a radar cross section of 1 m^2 . Its antenna is 12 mt wide by 4 mt high and the antenna aperture efficiency is 0.65. the receiver minimum detectable signal is 10^{-13} W . Determine:
- Antenna effective aperture 'Ae' in sq.mt
 - Peak Transmitter power
 - Pulse repletion frequency to achieve a maximum unambiguous range of 200 nmi. (06 Marks)
- 8 a. Explain the frequency response of the single delay line canceller and also obtain the expression for blind speeds. (08 Marks)
- b. Explain with a block diagram, the working of a digital MTI processor used in Radar systems. (08 Marks)
- c. A V.H.F radar at 220 MHz has a maximum unambiguous range of 180 nmi. What is its first blind speed? (04 Marks)

