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10EC54

Fifth Semester B.E. Degree Examination, May 2017
Microwaves and Radar

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. Using the methods of distributed circuit theory, derive the transmission line equation. **(07 Marks)**

b. Show that the voltage and current standing waves are 90° out of phase along the line. **(07 Marks)**

c. A lossless line has a characteristic impedance of 50Ω and is terminated in a load resistance of 75Ω. The line is energized by a generator which has an output impedance of 50Ω and an open circuit output voltage of 30 V (rms). The line is assumed to be 2.25 wavelengths long. Determine: i) the input impedance ; ii) the magnitude of the instantaneous load voltage ; iii) the instantaneous power delivered to the load. **(06 Marks)**

2 a. For a rectangular waveguide,
i) What is the critical condition for the evanescence and obtain the expression for cutoff frequency?
ii) Obtain the guide propagation constant when the wave is propagating.
iii) Obtain the guide propagation constant when the wave is attenuated. **(06 Marks)**

b. Derive the field equation for TM modes in rectangular waveguides. **(07 Marks)**

c. Explain the two-hole directional coupler with neat sketch and obtain the S-matrix of a directional coupler. **(07 Marks)**

3 a. Explain the modes of operation of Gunn diode in microwave oscillations. **(08 Marks)**

b. With an equivalent circuit, explain the parametric up-converter and mention the advantages of up-converter over the negative resistance devices. **(08 Marks)**

c. The drift velocity of electrons is 2×10^7 cm/s through the active region of length 10×10^{-4} cm. Calculate the natural frequency of the diode and the critical voltage. **(04 Marks)**

4 a. Show that the impedance and admittance matrices are symmetrical for a reciprocal junction. **(07 Marks)**

b. Find the S-matrix of a length ℓ of a lossless transmission line terminated by a matched impedance. **(05 Marks)**

c. List the properties of S-matrix and prove the symmetry and unitary properties of S-matrix for a reciprocal and lossless junction. **(08 Marks)**

PART – B

5 a. With a neat sketch, explain the precision type variable attenuator. **(06 Marks)**

b. With a neat sketch, explain the working principle of magic tee and also obtain the S-matrix. **(08 Marks)**

c. A 20 mW signal is fed into one of the collinear port 1 of a lossless H-plane T-junction. Calculate the power delivered through each port when other ports are terminated in matched load. **(06 Marks)**

6 a. Describe the dielectric losses and ohmic losses in microstrip lines. **(10 Marks)**

b. A lossless parallel strip line has a conducting strip width w. The substrate dielectric separating the two conducting strips has a relative dielectric constant $\in_{rd}$ of 6 and a thickness of 4 mm. Calculate: (i) the required width w of the conducting strip in order to have a characteristic impedance of 50Ω, (ii) the strip line capacitance, (iii) the strip line inductance, (iv) the phase velocity of the wave in the parallel strip line. **(06 Marks)**

c. Explain the coplanar strip line. **(04 Marks)**

7 a. Derive an expression for maximum range of a radar in terms of transmitted and received signal power. **(05 Marks)**

b. With neat block diagram, explain the conventional pulse radar with a super heterodyne receiver. **(07 Marks)**

c. A ground based air surveillance radar operates at a frequency of 1300 MHz. 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 m wide by 4 m high, and the antenna aperture efficiency is 0.65. The receiver minimum detectable signal is 10^{-13} W. Determine:

i) Antenna effective aperture and antenna gain in dB.

ii) Peak transmitter power

iii) Pulse repetition frequency to achieve a maximum unambiguous range of 200 nmi

iv) Average transmitter power if the pulse width is 2 μs

v) Horizontal beam width. **(08 Marks)**

8 a. Derive an expression for Doppler frequency shift in terms of radial velocity. **(04 Marks)**

b. Explain the blind phases, I and Q channels and also with neat block diagram, explain the digital MTI signal processor. **(10 Marks)**

c. What is the highest frequency that a radar can be operated if it is required to have a maximum unambiguous range of 200 nmi and no blind speeds less than 600 Kt? **(06 Marks)**

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