Microwave Circuits and Applications (ETC 941)

Time: 3 hours   Full Marks: 70

Group A

Answer any three questions from this group. Two marks are reserved for neatness

1. (a) Define Scattering parameters of a two-port network in term of wave variables. Mention reciprocal and symmetrical properties of S-parameters. Write down power conservation laws of S-parameters.

   (b) Find out the expression of the input impedances, when output port of the transmission line network is short circuited and also when open circuited.

   (c) Define VSWR, phase delay and group delay.

   $$[5+3+3]$$

2. (a) How do EM wave propagate through a microstrip line? How the characteristic impedance and effective relative permittivity relates parallel plate and fringing capacitances.

   (b) A microstrip line has substrate of relative permittivity $\varepsilon_r = 3.2$. If the ratio of line width to substrate thickness is $w/h = 4.5$, determine (i) effective relative permittivity (ii) characteristic impedance (iii) wavelength of the line at 6 GHz

   (c) Describe the construction and features of a co-planar waveguide (CPW) line.

   $$[5+4+2]$$

3. (a) Draw the electrical field distribution of a coupled microstrip lines and describes their parallel plate and fringing capacitances.

   (b) What do you understand by even mode and odd mode propagation? Find out the expression for characteristic impedance and effective dielectric constant for even mode and odd mode excitation.

   (c) What type of circuit components are designed using coupled microstrip lines.

   $$[4+5+2]$$

4. (a) Write down the nth order Butterworth function in term of normalized frequency. Hence drive its lowpass approximate filter function.

   (b) Write down the lowpass prototype filters for all-pole filters with a ladder network structure.

   (c) Find out the element values for 5th order Butterworth lowpass prototype filter.

   $$[4+5+2]$$

5. (a) What do you understand by Quasi-lump elements of microstrip? How are inductances/capacitances realized by low and high impedance short microstrip line?

   (b) Describe the design steps of a 5th order microstrip lowpass filter using Low and high impedance lines.

   (c) What are immittance inverters and how are they useful for design microwave filters?

   $$[4+4+3]$$

Group-B

Answer any three questions. Two marks are reserved for neatness

6. (a) What do you understand by MUF? What is its relation with angle of incidence of radio wave at ionosphere?

   (b) How does group velocity differ from phase velocity of a radio wave?

   (c) Derive an equation between virtual height and transmission path distance for an ionospheric transmission. Hence, calculate the transmission path distance that utilizes a layer of virtual height 200 km. The angle of elevation of the antenna beam is 30^0. [Radius of earth = 6370 km]   3+3+5

7. (a) Find the expression for electric field at a receiving antenna, operating in the tropospheric region, in terms of height of the transmitting and receiving antenna and separation distance between them.

   (b) In a VHF mobile radio system, the base station transmits 60 W at 100 MHz, and the antenna is 20m above the ground. The transmitting antenna is a half-wave dipole for which the gain is 1.64. Calculate the field strength at a receiving antenna of height 2m at a distance of 40km.   8+3

8. (a) Discuss channel noise and losses in ground wave propagation in the light of AWGN, ground reflection loss, diffraction and total path loss.

   (b) For carrier frequency around 1 GHz, the base station height is 30m and the mobile antenna height is 2m. Find out the turnover distance when the signal is transmitted from the base station to the mobile.   9+2

9. (a) Explain briefly various propagation effects due to which free space RADAR performance is modified.

   (b) Assuming the earth as a plane, smooth and perfect reflector, examine forward scattering effects for RADAR propagation in the light of received echo power, lobing and surface reflection co-efficient.   3+8

10. (a) Explain briefly with suitable exhibits TDMA frame structures in GSM. What do you understand by spectral efficiency and cell capacity of TDMA system? How error protection for speech signals in GSM is done?

(b) If a normal GSM time slot consists of six trailing bits, 8.25 guard bits, 26 training bits and two traffic bursts of 58 bits of data, find the frame efficiency.   9+2

11.   Write short notes on the following: (any two)   11

            (a) Small scale fading in wireless communication.

            (b) Active and passive repeaters.

            (c) Spread Spectrum Multiple Access for wireless communication.

            (d) Bidirectional satellite link for video communication.

            (e) MTI Radar.