Registration no:

Total Number of Pages: 02

M .TECH
ETPC201

Second Semester Examination 2013
MICROWAVE AND ANTENNA ENGINEERING

Time: 3 Hours

Max marks: 70

Answer Question No.1 which is compulsory and any five from the rest.

The figures in the right hand margin indicate marks.

Q1 Answer the following questions: (2 x 10)

a) What is the input impedance of a half-wavelength lossless transmission line terminated in a load $(50+j75)$ ohms?

b) What is the minimum length of the fixed section (between two stubs) in a double stub matching arrangement?

c) In a symmetrical MW Tee junction $S_{13} = S_{23}$. What type of Tee is this?

d) How can a z-directed Hertizan dipole's far field intensity E along Y-axis be represented as a combination of LCP and RCP waves?

e) What is the effective electrical length of a $\lambda/2$ dipole?

f) When do you expect a Gunn device to exhibit amplification rather than oscillation and why so?

g) Why is the loop antenna called a magnetic dipole?

h) What is the value of the progressive phase shift 'α' of an N-element End Fire Array with spacing between elements equal to $\lambda/4$?

i) The maximum radiation intensity of a 90% efficient antenna is 200 mW/sterradian. Find its directivity if the input power is 125 mW.

j) What are the two effects called by which IMPATT diodes exhibit a differential negative resistance?

Q2 a) A lossless, 50 ohm airfield coaxial line has $V_{max} = 2.5$ V and $V_{min} = 1$ V when terminated with an unknown load. The distance between the successive voltage minima is 5 cm and the first voltage minimum from the load end is 1.25 cm. Design a shorted single stub for impedance matching. (5)

b) What is a microstrip line and how is it different from a strip line? What electromagnetic modes are supported in such a line? What parameters of a microstrip line determine its characteristic impedance? What are the losses encountered in a microstrip structure? (5)

Q3 a) Show by using unity and zero properties of 'S' matrix that the diagonal elements of the 'S' matrix of a Tee junction are not all zeroes. (5)

b) What is a Directional Coupler? How are its characteristics expressed? How can it be used in microwave high power measurement? Show that the spacing between centres of the two holes in a two-hole directional coupler must be an odd multiple of a quarter wavelength. (5)

Q4 a) Starting from Maxwell's equations derive the vector wave equations for the uncoupled vector magnetic potential $\bar{A}$ and scalar electric potential (5)

V related to the source current and source charge existing in antennas.

b) Compute the directivity of an antenna, the power pattern of which is given by (5)

$$U(\theta, \Phi) = \begin{cases} \sin\theta \sin\Phi & 0 \le \theta \le \pi;\ 0 \le \Phi \le \pi \\ 0 & 0 \le \theta \le \pi;\ \pi \le \Phi \le 2\pi \end{cases}$$

Q5 a) Derive mathematically the expression for the condition of negative resistance in an n-type GaAs semiconductor bulk device and hence explain the criteria for the negative resistance property. (6)

b) An n-type GaAs Gunn diode has the following parameters. (4)

(i) Electron drift velocity = 250000 m/s

(ii) Negative electron mobility = $0.015 m^2 / V-S$

(iii) Relative dielectric constant = 13.1

Determine the criteria for classifying the modes of oscillation.

Q6 a) What must be the equation for the surface of an antenna to have frequency independent characteristics? Analyze as per the findings of V.H. Rumsey. (5)

b) A log periodic dipole array operates over 10 MHz to 30 MHz range. Given the scale factor to be 0.895 and the spacing factor as 0.166, find the number of elements in the array and the lengths of the shortest and just next to the shortest dipole. Why is it called log periodic? (5)

Q7 a) Define element pattern and Array factor of *N* z-directed infinitesimal dipoles radiating into free space. (5)

b) If the currents in a z-directed two elemental array of Hertzian dipoles placed symmetrically about the origin are in phase with each other, find out the expression for maxima and nulls to appear in the resultant pattern. Find the number of maxima and nulls when the spacing between these two elements $d = 2\lambda$. (5)

Q8 Write brief explanatory notes on *any two* of the followings: (5 x 2)

a) Magic Tee

b) Microstrip Antenna

c) Corner Reflector

d) Babinet's principle