M.Sc. 4th Semester Examination, 2012

ELECTRONICS

(Microwave Devices and Circuits)

(Theory)

PAPER – ELC-401

Full Marks : 50

Time : 2 hours

Answer **Q.No.1** and any **three** from the rest

The figures in the right hand margin indicate marks

Candidates are required to give their answers in their own words as far as practicable

Illustrate the answers wherever necessary

1. Answer the following questions : 2 × 5

(*a*) Microwave frequencies are perfectly suitable for satellite communication – Explain with reasons.

(*b*) Write down the electric and magnetic wave equations of electromagnetic wave in standard form. Hence find the expression for propagation constant.

(*c*) Draw the I - V characteristic of a tunnel diode. Explain why the negative resistance is essential for generation of oscillation.

(*d*) What is cut-off frequency with reference to EM wave propagation in a rectangular waveguide? Find an expression for the same for dominant mode in TE.

(*e*) Given the following values for an *n*-type GaAs Gunn diode :

Electron density at lower valley $n_l = 10^{10}$ cm^{-3}
electron density at upper valley $n_u = 10^8$ cm^{-3}
Temperature $T = 300$ K
Mobility $\mu_l = 8000$ cm^2/*v*-sec
Mobility $\mu_u = 180$ cm^2/*v*-sec
Find the conductivity of the Gunn diode.

2. (*a*) Describe the utilities of microwave waveguides.

(*b*) Define the dominant mode in a particular waveguide.

(*c*) An air filled rectangular waveguide of inside dimensions 8×4 cms operates in the dominant TE_{10} mode.

(*i*) Find the cut-off frequency

(*ii*) Determine the phase velocity of the wave in the guide at a frequency of $4GH_3$

(*iii*) Determine the guided wavelength at the same frequency. $2 + 2 + 6$

3. (*a*) What do you mean by microwave crossed field tubes ?

(*b*) Describe the principle of operation for a cylindrical magnetron

(*c*) An X-band cylindrical magnetron has the following parameters :

Anode voltage $V_0 = 25$ kV

Beam current $I_0 = 25$ A

Magnetic flux density $B_0 = 0{\cdot}33$ Wb/m^2

Radius of the cathode cylinder $a = 5$ cm

Radius of van edge to centre $b = 10$ cm

Find :

(*i*) The cyclotron angular frequency

(*ii*) The cut-off voltage for a fixed B_0

(*iii*) The cut-off magnetic flux density for a fixed V_0. 1 + 4

4. (*a*) Distinguish between avalanche transit time devices and the transferred electron devices.

(*b*) Describe the operating principle of a Read diode.

(*c*) What do you mean by avalanche – multiplication for such a diode ?

(*d*) An IMPATT diode has the following parameters

Carrier driff velocity $V_d = 2 \times 10^7$ cm/s

driff region length $L = 5$ μm

maximum operating voltage $V_{0max} = 100$V

maximum operating current $I_{0max} = 200$ mA

efficiency $\eta = 15\%$
breakdown voltage $V_{bd} = 90V$

find (*i*) the maximum CW output power and (*ii*) the resonant frequency. 2 + 3 + 2 + 3

5. (*a*) With a neat schematic diagram describe the construction of a strip line.

(*b*) Draw the field lines for such a strip-line.

(*c*) Describe various losses in microstrip lines.

(*d*) A microstrip line has the following parameters :

$\epsilon_r = 5{\cdot}25$
$h = 7$ mils
$t = 2{\cdot}8$ mils
$w = 10$ mils

Calculate the characteristic impedance z_0 of the line. 2 +2 + 3 + 3

6. (*a*) Draw a simplified schematic diagram of a helix traveling wave tube and explain its working.

(*b*) A traveling wave tube operates under the following parameters :

Beam voltage $V_0 = 3$ kV

Beam current $I_0 = 30$ mA

Characteristic impedance of helix $z_0 = 8\ \Omega$

Circuit Length $N = 50$

Frequency $f = 8$ GHz

Determine (*i*) the gain parameter C and (*ii*) the output power gain A_p in decibels. 5 + 5

[*Internal Assessment* – 10 Marks]