Subject: MICROWAVE THEORY AND TECHNIQUES

Time: 3 Hours **JUNE 2011** **Max. Marks: 100**

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks. Answer to Q.1 must be written in the space provided for it in the answer book supplied and nowhere else.**
- **The answer sheet for the Q.1 will be collected by the invigilator after 45 Minutes of the commencement of the examination.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or the best alternative in the following: (2×10)

a. A transmission line has following parameters R = 2 Ω/m, G = 0.5 m mho/m, L = 8 nH/m, C = 0.23 pF, f = 1GHz, Its characteristic impedance is given by ______.

(A) 50 Ω **(B)** 75 Ω
(C) 100 Ω **(D)** 179.44+j26.50

b. A certain transmission line has a characteristic impedance of 75 + j0.01 Ω and is terminated in a load impedance of 70 + j50 Ω. The reflection coefficient is _____

(A) 0.8+j40 **(B)** 0.6+j50
(C) 0.9+j60 **(D)** 0.08+j0.32

c. A micro wave circulator is a multiport junction where the power can flow from _______

(A) port(1) to port(2) and port(2) to port(3) etc
(B) port(3) to port(2) and port(2)to port(1)
(C) port 1 to all other ports
(D) microwave circulators cannot be used for power carrying purposes

d. A two cavity Klystron is a widely used microwave amplifier operated by ______ and ________ .

(A) Velocity and current modulation
(B) Electron motion
(C) On same principals as low frequency tubes
(D) Slow wave structure

e. Crossed field tubes derive their names from the fact that

(A) D.C electric field and D.C magnetic field are perpendicular to each other
(B) A.C magnetic field and A.C electric field are horizontal to each other
(C) A.C magnetic field and A.C electric field are perpendicular to each other
(D) There is no relation between A.C magnetic field and A.C electric field

f. X band pulsed cylindrical magnetron has magnetic flux density $B_O = 0.336$ wb/mt^2, its cyclotron angular frequency is ________.

(A) 5.91×10^{10} rad　　**(B)** 11×10^{10} radians
(C) 5×10^{5} rad　　**(D)** 6×10^{5} radians

g. A certain Si JFET has the following parameters channel height a = 0.1μm, Electron concentration $N_d = 8\times10^{17}$cm^{-3} Relative dielectric constant $\varepsilon_r = 11.8$ Then the pinch off voltage is given by ______.

(A) 60 volts　　**(B)** 106.6 volts
(C) 88 volts　　**(D)** 6.66 volts

h. The phase velocity of a TEM wave can be expressed by the relation which is the velocity of light in an unbounded dielectric is given by __________.

(A) $V_p = w/\beta_g$　　**(B)** $V_p = w/\beta_o$
(C) $V_p = w/w_o$　　**(D)** $V_p = \beta_g/\beta_o$

i. The tunnel diode is a ____________ resistance semiconductor p-n junction diode

(A) positive　　**(B)** negative
(C) high　　**(D)** low

j. In a directional coupler all four ports are completely matched, and then diagonal elements of the S matrix are given by ________.

(A) $S_{11} = S_{22} = S_{33} = S_{44} = 0$　　**(B)** $S_{11} = S_{22} = S_{33} = S_{44} = 1/\sqrt{2}$
(C) $S_{11} = S_{22} = S_{33} = S_{44} = 1$　　**(D)** $S_{11} = S_{22} = S_{33} = S_{44} = 3/2$

Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks.

Q.2 a. With the help of transmission line equation derive the expression for characteristic impedance Z_0 and phase velocity V_p. **(6)**

b. A transmission line has a characteristic impedance of 50+j0.01Ω and is terminated in a load impedance of 73-j42.5Ω. Calculate the (i) Reflection coefficient (ii) The standing wave ratio **(6)**

c. Write a note on single stub matching **(4)**

Q.3 a. Explain power is losses in rectangular waveguides. **(8)**

b. An air filled rectangular wave guide of inside dimensions 7×3.5 cms operates in the dominant TE_{10} mode as shown in Fig.1
(i) Find cut off frequency　　(ii) Phase velocity of wave at 3.5GHz
(iii) λg, the guide wave length **(8)**

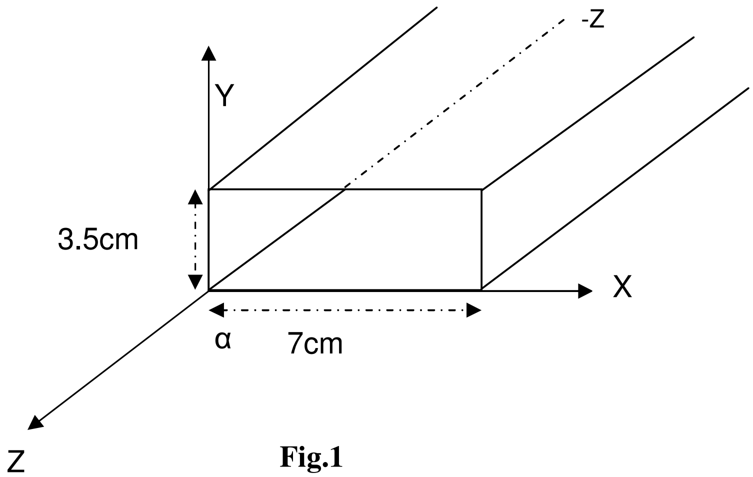

Fig.1

Q.4 a. What are directional couplers, explain with a neat diagram. Derive an expression for an S matrix of directional coupler **(8)**

b. Writ short notes on: (i) Microwave Hybrids (ii) Microwave Isolator **(8)**

Q.5 a. Explain the principles of operation of microwave tunnel diode. **(6)**

b. Draw a neat diagram of TRAPATT diode; explain the principle of operation with neat figures **(4)**

c. Avalanche zone velocity of a TRAPATT diode has following parameters. Doping concentration $N_A = 2\times10^{15}\ cm^{-3}$, current density $J = 20\ KA/cm^2$. Calculate the avalanche-zone velocity. **(6)**

Q.6 a. Write the schematic diagram of two cavity klystron amplifier and explain the velocity modulation process **(8)**

b. A two cavity Klystron has following parameters $V_o = 1000$ volts, $R_o = 40\ K\Omega$, $I_o = 25$ mA, f = 3GHz. The gap spacing in either cavity is d = 1mm spacing between two cavities L = 4cms, Effective shunt impedance, excluding beam loading $R_{sh} = 30K\Omega$. Calculate the efficiency of the amplifier neglecting beam loading. **(8)**

Q.7 a. Draw the schematic diagram of a cylindrical magnetron oscillator and explain its action **(6)**

b. Obtain Hull cut off magnetic equation and cut off voltage for cylindrical magnetron. **(5)**

c. An X band pulsed cylindrical magnetron has the following operating parameters. Anode voltage $V_o = 26$ K volts, Beam current $I_o = 27$ A, Magnetic flux density $B_o = 0.336\ wb/m^2$. Radius of cathode cylinder a = 5 cms, Radius of vane edge to center = b = 10 cms, compute the (i) cyclotron angular f_r (ii) Cut off voltage for a fixed B_o (iii) The cut off magnetic flux density **(5)**

Q.8 a. Explain the microstrip lines and the associated losses. (

b. A lossless parallel strip line has strip width W, $\varepsilon_{rd} = 6$ and thickness d = 4 mm. Calculate (i) Required width W of the conducting strip in order to have a characteristic impedance of 50 Ω (ii) Strip line capacitance (iii) Strip line impedance (iv) The phase velocity in parallel strip line **(8)**

Q.9 a. Write short note on

(i) Monolithic microwave integrated circuit
(ii) DC Sputtering **(8)**

b. Briefly explain MMIC fabrication techniques. **(8)**