ROLL NO. _____

Code: AE72 Subject: MICROWAVE THEORY AND TECHNIQUES

AMIETE – ET

Time: 3 Hours **DECEMBER 2013** **Max. Marks: 100**

PLEASE WRITE YOUR ROLL NO. AT THE SPACE PROVIDED ON EACH PAGE IMMEDIATELY AFTER RECEIVING THE QUESTION PAPER.

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. The standing wave ratio of a pure travelling wave is _____ and that of a pure standing wave _____.

(A) unity, infinity **(B)** zero, unity
(C) infinity, unity **(D)** infinity, zero

b. If the parameters of a transmission line are R = 2 Ω/m, G = 0.5 mho/m, f = 1 GHz, L = 8nH/m and C = 0.23 pF, the propagation constant is:

(A) 0.273 + j0.051 **(B)** 0.051 + j0.273
(C) 0.051 – j0.273 **(D)** 0.273 – j0.051

c. Which one of the following modes has the characteristic of attenuation becoming less as the frequency is increased and is attractive at microwave frequencies for circular cylindrical waveguides?

(A) TE_{11} mode **(B)** TM_{01} mode
(C) TE_{01} mode **(D)** higher order mode

d. For a rectangular resonator, the maximum amplitude of a standing wave occurs when the frequency of the impressed signal is _____ the resonant frequency.

(A) greater than **(B)** smaller than
(C) varying **(D)** equal to

e. For matching over a range of frequencies in a transmission line, it is best to use:

(A) a balun **(B)** a broad band directional coupler
(C) a double stub **(D)** a single stub of adjustable position

f. In TE and TM modes of rectangular waveguide having propagation in z-direction,

(A) E_z and H_z are both zero
(B) In TE mode, E_z is zero and in TM mode H_z is zero
(C) In TE mode, H_z is zero and in TM mode E_z is zero
(D) In both TE and TM modes, both E_z and H_z are non-zero

g. In a TWT, the phase velocity of the axial component of the field on the slow wave structure is kept

(A) equal to velocity of electron
(B) slightly less than velocity of electron
(C) slightly more than velocity of electron
(D) equal to velocity of light in free space

h. Which of the following can be used for amplification of microwave energy?

(A) TWT **(B)** Magnetron
(C) Reflex klystron **(D)** Gunn diode

i. The path length between ports 1 and 2 for the two waves in a hybrid ring is:

(A) 1 **(B)** $3\lambda/4$
(C) $\lambda/2$ **(D)** $\lambda/4$

j. Which of the following is an active microwave device?

(A) Stripline **(B)** Microstrip
(C) SAW device **(D)** IMPATT

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

Q.2 a. What is meant by impedance matching? Explain single stub matching and give its drawbacks. **(10)**

b. A 600Ω lossless transmission line is fed by a 50Ω generator. If the line is 200 m long and terminated by a load of 500Ω, determine in dBs:
(i) Reflection loss
(ii) Transmission loss
(iii) Return loss **(6)**

Q.3 a. By making use of Maxwells equations, show that a TEM wave cannot propagate in a waveguide. **(10)**

b. Given a rectangular waveguide 3×1 cm operating at a frequency of 9 GHz in TE_{10} mode. Calculate the maximum power handling capacity of the waveguide if the maximum potential gradient of the signal is 3 kV/cm. **(6)**

Q.4 a. Explain the functioning of a rat race junction. Also, write the scattering matrix of a rat race junction under ideal condition i.e. neglecting leaking coupling values. **(10)**

b. A signal of power 32 mW is fed into one of the collinear ports of a lossless H-Plane Tee. Determine the powers in the remaining ports when other ports are terminated by means of matched loads. **(6)**

Q.5 a. What is a tunnel diode? Explain the volt-amp characteristics of a tunnel diode. **(10)**

b. An IMPATT diode has a drift length of 2 μm. Determine:
(i) Drift time of the carrier.
(ii) Operating frequency of the diode. **(6)**

Q.6 a. Explain how a helical TWT achieves amplification. Give the applications of TWT and also explain how TWTs are different from klystron amplifiers. **(10)**

b. A reflex klystron operates at the peak mode of n = 2 with V_o= 280 V, I_o = 22 mA and signal voltage V_1 = 30 V. Determine:
(i) The input power
(ii) The output power
(iii) The efficiency **(6)**

Q.7 a. What are crossfield devices? How does a magnetron sustain its oscillations using this crossfield? Assume π - mode for explaining the same. **(10)**

b. An Amplitron has the following operating parameters:
Anode voltage V_o = 15kV
Anode current I_o = 3A
Magnetic flux density B_o = 0.2 wb/m^2
Operating frequency f = 8GHz
Characteristic impedance Z_0 = 50Ω
Determine:
(i) The dc electron- beam velocity
(ii) The electron- beam phase constant
(iii) The cyclotron angular frequency **(6)**

Q.8 a. Describe striplines and microstrip lines in detail. Give the advantages disadvantages of microstrip lines. **(10)**

b. A strip line transmission line has a distance of 0.3175 cm between the ground planes. If the diameter of the equivalent circular conductor is 0.0539 cm, determine the characteristic impedance and velocity of propagation if the dielectric constant is 2.32 for the strip line material. **(6)**

Q.9 a. Differentiate between discrete circuits, integrated circuits and monolithic microwave integrated circuits. What are the broad categories into which the basic materials used for MMIC fabrication are divided into? Write short notes on each of them. What are the disadvantages of MMICs? **(10)**

b. Describe a thin film planar resistor and express the resistance in terms of its parameters. **(6)**