ROLL NO. _____

Code: AE72 Subject: MICROWAVE THEORY AND TECHNIQUES

AMIETE – ET

Time: 3 Hours **JUNE 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 phase velocity v_p and group velocity v_g are related to C, the free space velocity by _____ relation.

(A) $v_p / v_g = C$ **(B)** $v_p v_g = C^2$

(C) $v_p v_g = C^3$ **(D)** $\sqrt{\frac{v_p}{v_g}} = C$

b. Microwave crossed field tubes device their names from the fact that _____.

(A) DC electric field and DC magnetic field are perpendicular to each other.
(B) AC electric field and AC magnetic field are horizontal to each other.
(C) AC electric field and DC magnetic field are perpendicular to each other.
(D) There is no relation between any of these fields.

c. If X band pulsed cylindrical magnetron has magnetic flux density $B_o = 0.336\,\text{wb}/\text{mt}^2$ its cyclotron angular frequency is _____

(A) $\omega_c = e/m\, B_o = 5.91\times10^{10}\,\text{rad}$ **(B)** $\omega_c = \frac{em}{B_o} = 11\times10^{10}\,\text{rad}$

(C) $\omega_c = emB_o = 5\times10^{5}\,\text{rad}$ **(D)** $\omega_c = \frac{mB_o}{e} = 6\times10^{5}\,\text{rad}$

d. A microwave 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) 3 to 2 and 2 to 1 etc
(C) no power flows from any port
(D) microwave circulator cannot be used for power carrying purpose

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

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

f. The modes of oscillations in an n-type GaAs is/are

(A) Gunn oscillation mode, LSA oscillation mode, Stable amplification mode and Bias-circuit oscillation mode
(B) Gunn oscillation mode only
(C) LSA mode only
(D) Bias-circuit oscillation mode only

g. A two cavity klystron is a widely used microwave amplifier operated by

(A) velocity and current modulation
(B) electron motion
(C) on same principles as low frequency tubes
(D) slow wave structure

h. TWT the travelling wave tube uses _____ as a slow wave structure.

(A) wave guide **(B)** wire
(C) a long helix **(D)** none of these

i. A certain Si JFET has the following parameters channel height $a = 0.1\mu m$, electron concentration $N_d = 8\times10^{17} cm^{-3}$, Relative dielectric const. $\in_r = 11.8$. Then V_p, the pinchoff voltage, is given by

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

j. A rectangular wave guide cannot support a _____ wave.

(A) TM mode **(B)** TEM mode
(C) TE mode **(D)** None of these

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

Q.2 a. List out the different types of transmission lines used at low frequency and at RF frequency with neat figures. Why wave guides are used at microwave frequencies. **(8)**

b. Explain Smith Chart, explain how VSWR can be obtained from it. Give example. **(8)**

Q.3 a. Starting from Maxwell's equations device wave equation for rectangular wave guide. **(10)**

b. Calculate the voltage attenuation provided by a 25cm length of wave guide having a = 1 cm and b = 0.5 cm in which 1 GHz signal is propagated in dominant mode, {symbols have usual meaning} **(6)**

Q.4 a. Explain the performance of a directional coupler with a neat diagram. Derive an expression for [S] matrix of directional coupler. **(10)**

b. Write short notes on:
(i) Magic T (ii) Microwave circulator **(6)**

Q.5 a. Explain the concept of negative differential conductivity. Explain the different modes of oscillation of Gunn diode. **(10)**

b. Write a note on principle of operation of microwave Tunnel diode. **(6)**

Q.6 a. A Reflex klystron operates under the following conditions:

$V_o = 600\text{volts}, \alpha = 1\text{mm}, R_{sh} = 15\text{K}\Omega, \ {}^{e}\!/_{m} = 1.759 \times 10^{11}, f_r = 9\text{GHz}$

The tube is operating at $f_v f_r$ at the peak of the n = 2 mode or $1\frac{3}{4}$ mode. The transit time through the gap and beam loading can be neglected. Find the value of repeller voltage V_r. **(8)**

b. Write a Schematic diagram of reflex klystron. Explain the action of the tube giving importance to applegate diagram. **(8)**

Q.7 a. Describe the principle of operation for a normal cylindrical magnetron and derive equation for cyclotron angular frequency. **(4+4)**

b. A circular carcinotron has the operating parameters

Anode voltage	Vo = 20kV
Anode Current	$I_o = 3.5\text{A}$
Magnetic flux density	$B_o = 0.3\,\text{Wb}/\text{m}^3$
Operating frequency	f = 4 GHz
Characteristic impedance	$Z_o = 50\Omega$
D factor	D = 0.8
b factor	b = 0.5

Compute:
(i) The dc electron velocity
(ii) The electron-beam phase constant
(iii) The delta differentials
(iv) The propagation constants **(8)**

Q.8 a. Derive an expression for quality factor Q of Micro-strip lines. **(6)**

b. Certain microstrip line has the following parameters
$\in_r = 5.23, h = 7\text{mils}, t = 2.8\text{mils}, \omega = 10\text{mils}$
Calculate the characteristic impedance Z_{10} of the line. **(6)**

c. Write a note on parallel strip line. **(4)**

Q.9 a. What are the advantages offered by MMIC over the discrete circuits? Discuss in detail the MMIC technique. **(8)**

b. Explain the types of planar capacitors commonly used in MMICs. **(8)**