ROLL NO. _____

Code: AE72/AE120
Subject: MICROWAVE THEORY AND TECHNIQUES

AMIETE – ET (Current & New Scheme)

December 2016

Time: 3 Hours **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. A transmission line has the primary constants R, L, G & C and secondary constants Z_0 & γ. If the line is lossless then
(A) $R = 0, G \neq 0$ and α=0
(B) $G = 0$ and $\alpha = \beta$
(C) $R = 0, G = \alpha$ and $\beta = |\gamma|$
(D) $R = G = \alpha = 0$ and $\beta = |\gamma|$

b. Percentage of incident power reflected from $100\,\Omega$ load of a $75\,\Omega$ transmission line is
(A) 2% **(B)** 1.43%
(C) 1% **(D)** 0.75%

c. In a single stub matching, the stub should be inserted at a point on the line where the normalized conductance is
(A) 0 **(B)** ∞
(C) 1 **(D)** 0.5

d. The dominant mode is defined as the mode having
(A) Lowest cut-off frequency
(B) Highest cut-off frequency
(C) The cut-off frequency equal to the frequency of the propagating signal
(D) Frequency independent characteristics

e. For a rectangular waveguide to support only the dominant TE mode, which of the following pairs of inequalities has to be satisfied
(A) $b < \lambda < 2b; \lambda > 2a$
(B) $b < \lambda < 2b; \lambda < 2a$
(C) $a < \lambda < 2b; \lambda > 2a$
(D) $a < \lambda < 2b; \lambda < 2a$

f. A cavity resonator can be represented by
(A) An LC circuit **(B)** An LCR circuit
(C) A lossy inductor **(D)** A lossy capacitor

g. In an E-H plane T-junction
(A) Both the E- and the H-plane arms produce a phase delay
(B) Both the E- and H-plane arms produces a phase advance
(C) The E-plane arm produces a phase delay, whereas the H-plane arm produces a phase advance
(D) The E-plane arm produces a phase advance, whereas the H-plane arm produces a phase delay

h. Which of the following is unlikely to be used as a pulsed device
(A) A travelling-wave tube **(B)** A crossed field amplifier
(C) A multi-cavity Klystron **(D)** A backward wave oscillator

i. The most serious drawback of an IMPATT diode is
(A) High noise
(B) Low efficiency
(C) Low power-handling capacity
(D) Inability to provide pulsed operation

j. The device exhibit non linear reactance
(A) Impett **(B)** Gunn
(C) Trapatt **(D)** Parametric Amplifier

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

Q.2 a. Derive transmission line equations using distributed circuit theory method. Use them to derive expression for characteristic impedance of the line. **(8)**

b. What do you understand by impedance matching in microwave transmission lines? Enlist various steps for doing single stub matching using Smith Chart. **(8)**

Q.3 a. An airfilled waveguide with a cross section 2×1 cm transports energy in the TE_{10} mode at the rate of 0.5hp. The impressed frequency is 30 GHz. What is the peak value of the electric field occurring in the guide? Assume the direction of propagation is in -z direction. **(8)**

b. Explain TEM mode in a circular waveguide. Derive relevant expressions and comment on them. **(8)**

Q.4 a. What do you understand by Q factor of cavity resonator? Also explain that how its coupling affects standing wave ratio. **(8)**

b. A symmetric directional coupler with infinite directivity and a forward attenuation of 20 dB is used to monitor the power delivered to a load Z_l as shown in Fig 1. Bolometer 1 introduces a VSWR of 2.0 on arm 4; bolometer 2 is matched to arm 3.

If bolometer 1 reads 8 mW and bolometer 2 reads 2 mW, find (i) the amount of power dissipated in the load Z_l (ii) the VSWR on arm 2. **(8)**

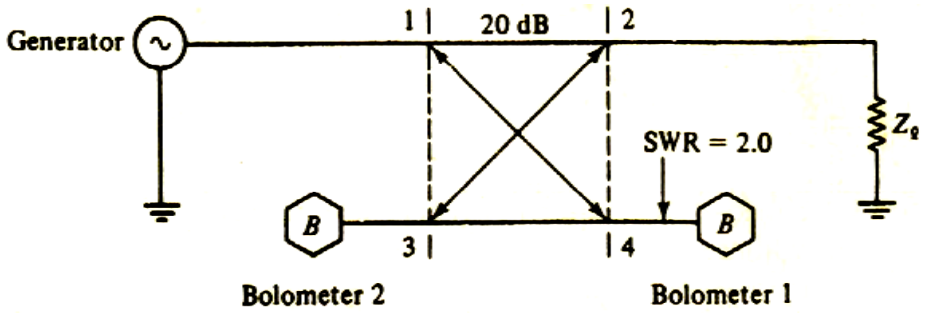

Fig. 1.

Q.5 a. Enlist the criterion of band structure in a semiconductor which must satisfy to exhibit negative resistance. Briefly explain each on the basis of Ridley-Watkins-Hilsum two-valley theory. **(8)**

b. Describe physical structure of a TRAPATT diode. Also give its principle of operation in brief. **(8)**

Q.6 a. The parameters of a two cavity amplifier klystron are as follows: Beam voltage $V_0 = 1200\,V$, beam current $I_0 = 28\,mA$, frequency $f = 8$ GHz, gap spacing in either cavity $d = 1$ mm, spacing between the two cavities $L = 4$ cm and effective shunt resistance $R_{sh} = 40\,k\Omega$ (excluding beam loading). Find:

(i) input microwave voltage V_1 in order to generate a maximum output voltage V_2 (including the finite transit-time effect through the cavities)
(ii) voltage gain (neglecting the beam loading in the output cavity)
(iii) calculate the efficiency of the amplifier (neglecting the beam loading). **(8)**

b. Describe amplification process in helix type travelling wave tube in detail with the help of neat diagrams and sketches. **(8)**

Q.7 a. Derive the expressions for output power and efficiency of a magnetron using equivalent circuit for its resonator. **(8)**

b. What do you understand by forward-wave crossed-field amplifier? Explain its principle of operation with the help of neat schematics. **(8)**

Q.8 a. Explain the need of microstrip lines. Discuss its various characteristics. **(8)**

b. Describe briefly coplanar and shielded strip lines. **(8)**

Q.9 a. Describe briefly fabrication techniques for a monolithic microwave integrated circuit. **(10)**

b. Write a short note on hybrid integrated circuit fabrication. **(6)**