

Code: AE20 Subject: MICROWAVE THEORY & TECHNIQUE  
**AMIETE – ET (OLD SCHEME)**

Time: 3 Hours

**JUNE 2012**

Max. Marks: 160

*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 microwave junction is supposed to be matched at all ports if in the S matrix
- (A) all the diagonal elements are zero  
(B) all the diagonal elements are equal but not zero  
(C) all the diagonal elements are complex  
(D) is Hermitian
- b. Horizontal polarization is nothing but
- (A) x-polarization (B) y-polarization  
(C) circular polarization (D) elliptical polarization
- c. At high frequencies, conventional vacuum tubes have limitations with the presence of
- (A) Transit time effects (B) low bandwidth  
(C) high noise (D) vacuum
- d. The maximum electronic efficiency of reflex klystron is
- (A) 40%. (B) 50%.  
(C) 22.7% (D) 35%.
- e. Directional coupler is
- (A) non-reciprocal device (B) reciprocal device  
(C) an amplifier (D) an oscillator

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- f. In a transmission line  $Z_L \neq Z_0$  and maximum voltage of the standing wave is 5 V & minimum voltage is 3 V then
- (A) VSWR=1.67dB (B) VSWR= 2.34dB  
(C) VSWR= 4.44dB (D) VSWR= 8.88dB
- g. The kinetic energy of the beam remains unchanged in the interaction between an electron beam & an RF wave in a
- (A) multi-cavity klystron. (B) crossed-field amplifier.  
(C) travelling wave tube (D) gyrotron
- h. The lowest TM mode in a rectangular waveguide of cross section  $a \times b$  with  $a > b$  will be
- (A)  $TM_{01}$  (B)  $TM_{10}$   
(C)  $TM_{12}$  (D)  $TM_{11}$
- i. The phase shift of a wave whose frequency is 1 GHz in free space
- (A) 21 rad/m (B) 20.93 rad/m  
(C) 40.93 rad/m (D) 0.3 rad/m
- j. The maximum unambiguous range in a system depends on
- (A) maximum power of the transmitter (B) pulse repetition frequency  
(C) width of the transmitted pulse (D) sensitivity of the radar receiver

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

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- Q.2** a. Explain Impedance matching. Describe the various methods of achieving impedance matching with their advantages and disadvantages. (12)
- b. How are waveguides different from normal two wire transmission lines? Discuss the similarities and dissimilarities (4)
- Q.3** a. What are cavity resonators? Derive the expression for resonant frequencies for a rectangular and circular resonator (8)
- b. The  $TE_{10}$  mode is propagated in a rectangular waveguide of dimensions  $a=6$  cms and  $b=4$  cms. By means of a travelling detector, the distance between a maximum and minimum is found to be 4.55 cms. Find the frequency of the wave (8)

- Q.4** a. Obtain the scattering matrix of E-H Plane Tee. (8)
- b. Explain the working of isolator, gyrator and circulator using ferrites. Mention their applications. (8)
- Q.5** a. What are the advantages achieved by adding more cavities in between the input and the output cavities in a klystron tube? With the help of relevant schematic and applegate diagram, briefly describe the bunching phenomenon in a two-cavity klystron. (8)
- b. What are slow wave structures? Explain how a helical TWT achieves amplification. (8)
- Q.6** a. A four cavity klystron VA-628 has the following parameters: beam voltage  $V_0=14.5$  kV, beam current  $=1.4$  A, operation frequency  $f=10$  GHz, dc electron charge density  $\rho_0=10^{-6}$  c/m<sup>3</sup>, RF charge density  $\rho=10^{-8}$  c/m<sup>3</sup>, velocity perturbations  $V=10^5$  m/sec. Determine (i) dc electron velocity (ii) the dc phase constant (iii) the plasma frequency, (iv) the reduced plasma frequency for  $R=0.4$  (v) the dc beam current density, (vi) the instantaneous beam current density. (8)
- b. Explain the different types of losses in Microstrip lines. (8)
- Q.7** a. Describe the method for measurement of impedance at microwave frequencies. (8)
- b. What are the limitations of conventional tubes at microwave frequencies? Explain how these limitations can be overcome (8)
- Q.8** a. What are avalanche transit time devices? Explain the operation, construction and application of the following:  
(i) IMPATT  
(ii) TRAPTT  
(iii) BARITT (12)
- b. Discuss the various factors that affect the satellite communications. (4)
- Q.9** Write short notes on any **TWO** of the following:  
(i) Horn antenna and slot antenna  
(ii) Tunnel Diode  
(iii) Magnetron  
(iv) Measurement of dielectric constant (2×8)