



Name : .....

Roll No. : .....

Invigilator's Signature : .....

**CS/B.TECH(ECE)/SEP.SUPPLE/SEM-7/EC-701/2012**

**2012**

**RF AND MICROWAVE ENGINEERING**

Time Allotted : 3 Hours

Full Marks : 70

*The figures in the margin indicate full marks.*

*Candidates are required to give their answers in their own words  
as far as practicable.*

**GROUP – A**

**( Multiple Choice Type Questions )**

1. Choose the correct alternatives for any *ten* of the following :  $10 \times 1 = 10$

i) A hollow waveguide behaves as

- a) Low Pass Filter
- b) Band Pass Filter
- c) High Pass Filter
- d) All Pass Filters.

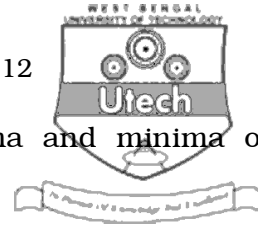
ii) The dominant mode of propagation in a rectangular waveguide is

- |              |                |
|--------------|----------------|
| a) $TE_{11}$ | b) $TE_{10}$   |
| c) $TM_{12}$ | d) $TM_{11}$ . |

- ension.



- viii) An example of Transferred electron device is
- a) Tunnel Diode
  - b) MESFET
  - c) Gun Diode
  - d) IMPATT Diode
- ix) The cavity magnetron uses strapping to
- a) prevent mode jumping
  - b) improve the phase focusing effect
  - c) ensure bunching
  - d) prevent cathode back-heating.
- x) For the transferred electron effect to occur the separation of energy between the lower and upper valley must be
- a) much larger than the thermal energy at room temperature
  - b) much lower than the thermal energy at room temperature
  - c) equal to the thermal energy at room temperature
  - d) none of these.
- xi) In a Strip line the dominant mode of propagation is
- a) TE
  - b) TM
  - c) TEM
  - d) none of these.



xii) Distance between successive maxima and minima of standing wave is

a)  $\frac{\lambda}{2}$

b)  $\lambda$

c)  $\frac{3\lambda}{4}$

d)  $\frac{\lambda}{4}$

**GROUP – B**

**( Short Answer Type Questions )**

Answer any *three* of the following.  $3 \times 5 = 15$

2. Derive the zero property of S matrix.
3. Explain the working principle of GUN diode with a suitable diagram.
4. A  $TE_{11}$  mode is propagating through a circular waveguide. The radius  $a$  of the guide is 5 c.m and the guide contains air as dielectric medium. Determine :
  - a) The cut-off frequency
  - b) The wavelength in the guide for an operating frequency of 3GHz. Given :  $X_{11} = k_c \cdot a = 1.841$  where  $k_c$  is the cut-off wave number.
5. Describe the operation of four-port microwave circulator.
6. Explain Transit Time and Mode Number of a Reflex Klystron with suitable diagram.



**GROUP – C**

**( Long Answer Type Questions )**

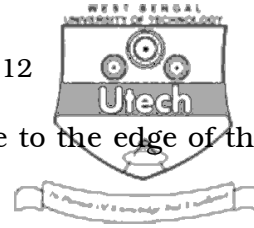
Answer any *three* of the following.  $3 \times 15 = 45$

7. a) Describe an ideal Directional coupler with the help of a suitable diagram. Define 'Coupling factor' and 'Directivity' in the context of a coupler.
- b) From the properties of a Directional coupler derive the S matrix of the ideal Directional coupler.
- c) Describe the working principle of a Faraday rotation isolator with the help of a suitable diagram.  $5 + 5 + 5$
8. a) Make a classification of different types of magnetrons.
- b) Draw the diagram of a cylindrical magnetron and derive the hull cut-off magnetic equation and the corresponding cut-off voltage.
- c) An X band pulsed cylindrical magnetron has the following operating parameters :

Anode Voltage  $V_0 = 26$  kV, Beam Current  $I_0 = 27$  A

Magnetic flux density  $B_0 = 0.336$  Wb /  $m^2$

Radius of cathode cylinder  $a = 5$  c.m.



Radius from the centre of the cathode to the edge of the anode  $b = 10$  c.m.

Compute :

- (i) The cyclotron angular frequency
- (ii) The cut-off voltage for a fixed  $B_0$
- (iii) The cut-off magnetic flux density for a fixed  $V_0$ .

5 + 5 + 5

- 9
- a) Define quality factor  $Q$  of a cavity resonator.
  - b) Derive an expression for the resonance frequency of a rectangular cavity ( $a \times b \times d$ ) for  $TE_{mnp}$  mode where the symbols bear the usual significance.
  - c) Draw the equivalent circuit of a cavity coupled by means of an ideal  $N : 1$  transformer and a series inductance  $LS$  to a generator having internal impedance  $Z_g$ . Hence derive the relation between loaded  $Q$ , unloaded  $Q$  and external  $Q$  of the system.
  - d) Describe critical coupling, overcoupling and undercoupling.
  - e) Draw with variation of VSWR with coupling coefficient.

2 + 3 + 2 + 3 + 3 + 2



10. a) Solve the Helmholtz equation in Cartesian coordinates. Hence discuss the three cases for the propagation constant in the waveguide.

b) Define TM mode. For  $TM_{mn}$  mode in a rectangular waveguide (  $a \times b$  ). Applying the solution of Helmholtz equation found in part (a) find  $E_y$  and  $H_y$ .

c) Find the phase velocity of the wave for the  $TM_{mn}$  mode in the waveguide.  $3 + 2 + 1 + 6 + 3$

11. Write short notes on any *three* of the following :  $3 \times 5$

- a) Tunnel Diode
- b) Gun Diode
- c) Velocity modulation in Klystron
- d) Stripline
- e) Optimum length and Flare angle of a horn antenna.

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