



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 × 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} . |



- 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) λ

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 × 5
- a) Tunnel Diode
 - b) Gun Diode
 - c) Velocity modulation in Klystron
 - d) Stripline
 - e) Optimum length and Flare angle of a horn antenna.

