

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.

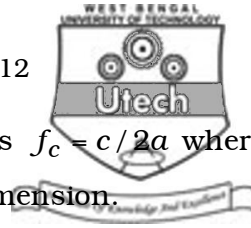
ii) The dominant mode of propagation in a rectangular waveguide is

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

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- iii) The cut-off frequency of TM_{10} mode is $f_c = c / 2a$ where
 c = velocity of light, a = waveguide dimension.
- a) True b) False.
- iv) Which of the following modes are characterized by
 $E_z = H_z = 0$?
- a) TE b) TM
- c) TEM d) none of these.
- v) Electromagnetic cavity resonators as energy store devices are used in
- a) klystron b) directional coupler
- c) circulator d) magic tee.
- vi) Microwave semiconductor devices are basically
- a) positive resistance device
- b) negative resistance device
- c) zero resistance device
- d) none of these.
- vii) A microwave circulator is a multiport waveguide junction by which the wave can flow only from the n -th port to $(n + 1)$ th port in one direction
- a) True b) False.

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

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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. $3 \times 5 = 15$

- Derive the zero property of S matrix.
- Explain the working principle of GUN diode with a suitable diagram.
- 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 :
 - The cut-off frequency
 - 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.
- Describe the operation of four-port microwave circulator.
- Explain Transit Time and Mode Number of a Reflex Klystron with suitable diagram.

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**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 $I_0 = 27$ AMagnetic flux density $B_0 = 0.336$ Wb / m^2 Radius of cathode cylinder $a = 5$ c.m.

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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 .

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- 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.

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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.
