*Name* : .....

*Roll No.* : .....

*Invigilator's Signature* : .....

**CS/B.Tech/ECE/SEM-7/EC-701/2012-13**

**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) Which of the following modes does not exist in a rectangular waveguide ?

a) TE b) TM

c) TEM d) None of these.

ii) The cut-off frequency for the dominant mode in an air-filled rectangular waveguide with internal dimension of 4 cm × 2·5 cm is

a) 7·5 GHz b) 6 GHz

c) 4·5 GHz d) 3·75 GHz.

iii) In a rectangular cavity which of the following modes does not exist ?

a) $TE_{110}$ b) $TE_{011}$

c) $TM_{110}$ d) $TM_{111}$.

iv) Caseagrain feed is used with parabolic reflector to

a) increase the gain of the system

b) increase the beam width of the system

c) reduce the size of the main reflector

d) allow the feed to be placed at a convenient point.

v) A Microstrip line is analogous to a

a) Co-axial line

b) Parallel wire line

c) Rectangular waveguide

d) Circular waveguide.

vi) Klystron operates on the principle of

a) amplitude modulation

b) frequency modulation

c) pulse modulation

d) velocity modulation.

vii) A magnetic field is used in the cavity magnetron to

a) prevent anode current in the absence of oscillations

b) ensure that the oscillations are pulsed

c) help in focussing the electron beam, thus preventing spreading

d) ensure that the electrons will orbit around the cathode.

viii) Gunn diode cannot be fabricated with which of the following materials ?

a) GaAs b) Si

c) InP d) CdTe.

ix) If the minimum range of radar is to be doubled, the peak power has to be increased by a factor

a) 2 b) 4

c) 8 d) 16.

x) The uplink and downlink frequencies of satallite communication are

a) 6 GHz, 4 GHz b) 4 GHz, 6 GHz

c) 6 GHz, 6 GHz d) 3 GHz, 5 GHz.

xi) Scattering parameter can be measured with the help of

a) Spectrum analyzer

b) Network analyzer

c) CRO

d) Bolometer.

xii) The range of microwave frequency is

a) 1 GHz to 2 GHz

b) 2 GHz to 4 GHz

c) 3 GHz to 300 GHz

d) 300 GHz to 3000 GHz.

## GROUP – B
## ( Short Answer Type Questions )

Answer any *three* of the following. 3 × 5 = 15

2. a) Compare the performance of rectangular waveguide and circular waveguide.

   b) Define the term 'dominant mode' and 'degenerate mode' as applied to waveguide. $2\frac{1}{2} + 2\frac{1}{2}$

3. What is an E-plane Tee ? Derive its S-matrix. 1 + 4

4. Explain the working principle of a 4-port circulator consisting of 2-Magic Tees and a non-reciprocal phase shifter.

5. Derive the Radar range equation.

6. Explain how 'velocity modulation' and 'current modulation' are achieved in reflex klystron.

## GROUP – C
## ( Long Answer Type Questions )

Answer any *three* of the following. 3 × 15 = 45

7. a) What is the difference between 'O-type' and 'M-type' microwave tubes ?

   b) Explain the function of two-cavity klystron amplifier with schematic diagram.

   c) The parameters of a two-cavity klystron amplifier are as follows :

   Beam voltage = 1200V, beam current = 28 mA, frequency = 8 GHz, gap spacing in either cavity $d$ = 1 mm and spacing between two cavities $L$ = 4 cm. Find maximum input voltage, gap transit angle, beam coupling co-efficient, DC transit angle. 2 + 8 + 5

8. a) Find out the expressions for the different components of electric and magnetic fields inside a rectangular waveguide for TE mode of propagation.

   b) Calculate the ratio of the cross-section of a circular waveguide to that of rectangular one if each is to have the same cut-off wavelength for its dominant mode.

10 + 5

9. a) What is the advantage of heterojunction bipolar transistor ( HBT ) over BJT ? Describe the operational mechanism of HBT.

   b) Derive the expression for the condition for negative differential mobility of 'transferred effectron devices'.

   c) What are different modes of operation of Gunn diode ?

( 2 + 4 ) + 5 + 4

10. a) Derive Fris's transmission formula. What do you mean by 'EIRP' and 'path loss' ?

    b) What is G/T ratio of an earth station ? What is its significance ?

    c) State the principle of operation of Moving Target Indication ( MTI ) Radar. ( 5 + 2 ) + ( 2 + 1 ) + 5

11. a) Explain how high value of VSWR can be measured by the double minimum method.

b) What do you mean by 'directivity' and 'effective aperture' of an antenna ? Derive the relation between directivity and effective apperture of a Horn antenna.

7 + ( 3 + 5 )

12. Write short notes on any *three* of the following : 3 × 5

a) Excitation modes in rectangular waveguide

b) TWT

c) IMPATT diode

d) Microstrip line

e) Bolometer.