Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B. Tech (ECE)/SEM-7/EC-701/2011-12

2011

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) The intrinsic impedance of free space is given by

      a) 333 Ω

      b) 377 Ω

      c) 233·5 Ω

      d) 379 Ω.

   ii) The range of *X*-band is

      a) 12-20 GHz b) 20-27 GHz

      c) 8-12 GHz d) 2-4 GHz.

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

      a) $\lambda/2$ b) λ

      c) $3\lambda/4$ d) $\lambda/4$.

iv) A TRAPATT diode is preferred to an IMPATT diode because of its

a) lower noise

b) larger bandwidth

c) higher efficiency

d) lesser sensitivity of harmonics.

v) Any two-port network having a 6 dB loss will give an output power which is ..... of input power.

a) 0·25 b) 0·50

c) 0·75 d) None of these.

vi) A cavity is a ..... filter.

a) Low pass b) High pass

c) Band pass d) Band reject.

vii) Large microwave power can be measured by

a) Bolometer

b) Thermistor

c) VSWR meter

d) Calorimeter-wattmeter.

viii) The dominant mode in a waveguide is characterized by

a) shortest cut-off wavelength

b) longest cut-off wavelength

c) zero attenuation

d) infinite attenuation.

ix) TWT is sometimes preferred to magnetron for use in RADAR transmitter because it

a) has broader band

b) is less noisy

c) is more efficient amplifier

d) is capable of larger duty cycle.

x) Magic-*T* is a

a) two-port network b) three-port network

c) four-port network d) one-port network.

xi) Reflex Klystron is a/an

a) Amplifier b) Oscillator

c) Attenuator d) Filter.

xii) Microwave components are generally characterised by

a) *h*-parameter b) *z*-parameter

c) *s*-parameter d) *y*-parameter.

GROUP – B

(Short Answer Type Questions)

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

2. What is IMPATT diode ? How does the negative resistance arise in this diode ?

3. a) What do you mean by Doppler frequency shift ?

b) Compare between Geo-synchronous and Geo-stationary satellites. 2 + 3

4. What is bunching ? Explain with proper diagram. Deduce the expression for the minimum length at which the first bunch will be formed.

5. a) What do you mean by cut-off frequency of a waveguide ?

   b) On what factors does the cut-off frequency of a waveguide depend ? Derive expressions in support of your answer.

6. A 200 Ω load is to be matched to a line with characteristic impedance of 300 Ω. Find the characteristic impedance of a quarter wave transformer to be inserted between them for the purpose of matching. Derive the formula to be used.

2 + 3

GROUP – C

(Long Answer Type Questions)

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

7. a) Define and explain the meaning of the term 'standing wave ratio' (SWR).

   b) Explain with a neat sketch, how the SWR in a rectangular waveguide can be measured.

c) What is Smith chart ? What are its applications ?

d) The dominant mode (TE_{10}) is propagated in a rectangular waveguide of dimensions a = 6 cm, b = 4 cm. The distance between two successive minima is 4·47 cm. Determine the signal frequency.

3 + 5 + (1 + 1) + 5

8. a) Define and explain the terms "coupling factor" and "directivity".

b) With neat sketch explain the working principle of a two-hole directional coupler.

c) A multi-hole directional coupler is fed with signal power of 2·8 mW at 10 GHz. The coupling factor is 3 dB and the directivity is better than 40 dB over X-band range. Find the distribution of power at all other ports.

d) An air filled rectangular waveguide of inside dimensions 7 cm × 3·5 cm operates the dominant TE_{10} mode. Find

i) the cut-off frequency and

ii) determine the guided wavelength at 3·5 GHz.

4 + 3 + 4 + 4

9. a) What is a rectangular cavity resonator ? Explain its working principle.

   b) Derive the expression of resonant frequency of a rectangular cavity resonator.

   c) Define quality factor Q for a rectangular cavity resonator.

   d) Calculate the resonant frequency of a rectangular cavity resonator with dimensions a = 25 mm, b = 10 mm and d = 20 mm, for TE_{102} mode.

   e) A rectangular waveguide of size $a \times b$ ($a > b$) is to operate in TE_{10} mode alone over a frequency range 10 to 15 GHz. Calculate the ranges of values within which a and b must lie if it is specified that the band centre is at 1·5 times the cut-off and the aspect ratio is 0·45.

   3 + 3 + 2 + 2 + 5

10. a) What are strip line and microstrip line ?

   b) What are the advantages and disadvantages of microstrip line ?

   c) Show the electric and magnetic field lines of microstrip line ?

   d) Explain the working principle of a microstrip antenna.

   3 + 3 + 4 + 5

11. a) Explain the working principle of a phase shifter.

b) Explain with experimental set-up the measurement of microwave high power.

c) Derive the scattering matrix of a Magic TEE.

d) How can you measure the microwave peak power from average power ? 3 + 5 + 5 + 2

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

a) CW Doppler RADAR

b) N-port circulator

c) Gunn diode oscillator

d) Bethe Hole coupler

e) Magnetron oscillator.