

Name :

Roll No. :

Invigilator's Signature :

CS/B.Tech (ECE-NEW)/SEM-7/EC-701/2010-11

2010-11

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) The degenerate modes of rectangular waveguide are

- a) TE_{11} and TM_{11}
- b) TM_{13} and TM_{31}
- c) TE_{13} and TM_{31}
- d) none of these.

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

- | | |
|---------------|---------------|
| a) TE_{110} | b) TE_{011} |
| c) TM_{110} | d) TM_{111} |

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- iii) An evanescent mode occurs when
- a) a wave is attenuated rather than propagated
 - b) the propagation constant is purely imaginary
 - c) $m = 0 = n$, so that field components vanish
 - d) none of these.
- iv) The broad wall dimension of a rectangular waveguide when the cut-off frequency for dominant mode is 3 GHz is
- a) 6 cm
 - b) 5 cm
 - c) 4 cm
 - d) none of these.
- v) The tunnel diode
- a) has a tiny hole through its centre to facilitate tunneling
 - b) is a point contact diode with very high reverse resistance
 - c) uses a high level of doping to provide a narrow junction
 - d) works by quantum tunneling exhibited by gallium arsenide.
- vi) In a microstrip antenna the radiation mostly takes place from
- a) edges of the patch
 - b) from the top surface of the patch
 - c) from the bottom surface of the patch
 - d) from the centre of the patch.

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- vii) In a two hole directional coupler the distance between two holes in terms of guided wavelength λ_g is
- a) λ_g
 - b) $\lambda_g/2$
 - c) $\lambda_g/4$
 - d) $2\lambda_g$.
- viii) Magnetron is
- a) an amplifier
 - b) an oscillator
 - c) both (a) & (b)
 - d) a phase shifter.
- ix) Microwave semi-conductor devices are basically a
- a) positive resistance device
 - b) negative resistance device
 - c) zero resistance device
 - d) high resistance device.
- x) Large microwave power can be measured by
- a) Calorimeter wattmeter
 - b) Bolometer
 - c) Wattmeter
 - d) Wavemeter.
- xi) An isolator is
- a) two-port network
 - b) one-port network
 - c) three-port network
 - d) four-port network.

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GROUP - B

(Short Answer Type Questions)

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

2. 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. Hence specify the disadvantages of circular waveguide over rectangular waveguide.
3. Prove that for any lossless N-port network sum of the products of any column or row of S-matrix with its conjugate is unity.
4. What is tunnel diode ? Describe its characteristics.
5. Derive the radar range equation.
6. Explain the principle of operation of a two hole directional coupler. What is the limitation of this structure ? $4 + 1$

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GROUP – C**(Long Answer Type Questions)**Answer any *three* of the following. $3 \times 15 = 45$

7. a) An air filled rectangular waveguide of inside dimensions 7×3.5 cm operates in the dominant TE_{10} mode.
- i) Find the cutt-off frequency
 - ii) Determine the guided wavelength of 3.5 GHz.
- b) Explain why a rectangular waveguide is preferred over a square waveguide for usual microwaves transmission.
- c) Define the term dominant mode and explain why wave propagation in a hollow metallic waveguide is preferred in this mode. $5 + 5 + 5$
8. a) Derive an expression for the resonant frequency of a rectangular cavity ($a \times b \times d$) with $a > b < d$ and hence obtain the dominant mode of resonance.
- b) Obtain the expression of Hz in the rectangular cavity of ($a \times b \times d$) in TE_{101} mode.
- c) What is ϕ -factor ? $6 + 7 + 2$

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9. a) Explain the operation of working of magnetron oscillator. Find an expression of cut-off magnetic field.

b) What are the various modes of operation in Gunn diode ? Show that in GaAs the mobility of electrons in lower valley of conduction band is greater than in higher valley and that electron transfer takes place from lower valley to higher valley of conduction band with increase in E-field.

8 + 7

10. a) What is a 'Directional coupler' ? Under what conditions it becomes an ideal directional coupler ? Define coupling factor, directivity and isolation factor.

b) Describe a Bethe Hole coupler. Explain its workings and obtain its coupling and directivity.

c) A directional coupler has a coupling factor of 15 dB and directivity of 30 dB. If the power in the coupling port is 32 microwatt, find the power in the input port and insertion loss.

5 + 5 + 5

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

- a) Microwave heating
 - b) Microwave satellite communication
 - c) Operating principles of MTI radar
 - d) IMPATT devices
 - e) Optimum length and Flare angle of a horn antenna.
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