Code No: V3220 **R07** **Set No: 1**

III B.Tech. II Semester Supplementary Examinations, April/May -2013

MICROWAVE ENGINEERING

(Electronics and Communication Engineering)

Time: 3 Hours **Max Marks: 80**

Answer any FIVE Questions

All Questions carry equal marks

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1. (a) Enumerate the basic advantages of Microwaves.
   (b) Draw the EM spectrum and list all the frequency ranges involved in microwave bands.
   (c) Briefly explain the applications of microwaves.

2. (a) Discuss the advantages and disadvantages of microstrip lines.
   (b) A circular waveguide operating in the dominant mode at a frequency of 9 GHz with a maximum field strength of 300 V/cm. The internal diameter is 5cm. Calculate the maximum power.

3. (a) What is the effect of discontinuity in a waveguide? Discuss in detail
   (b) How many types of waveguide phase shifters do you know? Discuss one type in detail.
   (c) Write a short note on resonant Iris.

4. (a) Explain the action of isolator, gyrator and circulator using ferrites. Mention their typical applications.
   (b) What are ferrites? Why are these useful in microwaves? Mention their properties.
   (c) Define Faraday rotation.

5. (a) What is velocity modulation? How is it different from normal modulation? Explain how velocity modulation is utilized in klystron amplifier.
   (b) A two cavity klystron is operated at 10GHz with V_0 =1200V, I_0=30mA, d=1mm, L=4cm and R_{sh}=40K Ω. Neglecting beam loading, calculate
   (i) Input RF voltage V_1 for a maximum output voltage
   (ii) Voltage gain and
   (iii) Efficiency

6. (a) Explain the working of a TWT amplifier with a neat sketch.
   (b) Compare TWT and Klystron amplifier.

7. (a) What are avalanche transit time devices? Explain the operation, construction and applications of the following devices:
   (i) IMPATT
   (ii) TRAPATT
   (b) Explain the Gunn effect using the two valley theory.

8. (a) Draw the block diagram of a microwave setup for measurement of high microwave powers and explain the procedure.
   (b) Explain any two methods of measuring microwave frequency.

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Code No: V3220 **R07** **Set No: 2**

III B.Tech. II Semester Supplementary Examinations, April/May -2013

MICROWAVE ENGINEERING

(Electronics and Communication Engineering)

Time: 3 Hours **Max Marks: 80**

Answer any FIVE Questions

All Questions carry equal marks

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1. (a) Determine the cutoff wavelength for the dominant mode in a rectangular waveguide of breadth 10cm. For a 2.5 GHz signal propagated in this waveguide in the dominant mode. Calculate the guide wavelength, group and phase velocities.
   (b) Derive the wave equation for a TM wave and obtain all the field components in a rectangular Waveguide.

2. (a) Show that a TEM wave cannot propagate in a waveguide by making use of Maxwell's equations.
   (b) Consider a guide of 8 cmx4 cm. Given a critical wavelength of TE_{10} = 16 cm, TM_{11} =7.16 cm and TM_{21}=5.6 cm. What modes are propagated at a free space wavelength of 10cm and 5 cm.

3. (a) Explain the operation of H-plane, E-plane and E-H plane Tee junctions. Why is a hybrid E-H plane tee referred to as Magic Tee? Derive the scattering matrix for all these Tees.

(b) A directional coupler has the scattering matrix given below. Find the directivity, isolation and coupling?

$$[S] = \begin{bmatrix} 0.05\angle 30^0 & 0.96\angle 0^0 & 0.1\angle 90^0 & 0.05\angle 90^0 \\ 0.96\angle 0^0 & 0.05\angle 30^0 & 0.05\angle 90^0 & 0.1\angle 90^0 \\ 0.1\angle 90^0 & 0.05\angle 90^0 & 0.04\angle 30^0 & 0.96\angle 0^0 \\ 0.05\angle 90^0 & 0.1\angle 90^0 & 0.96\angle 0^0 & 0.05\angle 30^0 \end{bmatrix}$$

4. (a) Obtain the scattering matrix for a three port circulator and also prove that it is impossible to construct a perfectly matched lossless, reciprocal three port junction?
   (b) Define scattering matrix. Discuss in detail about its significance and properties.

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5. (a) Draw a schematic diagram of a two-cavity klystron amplifier. With the help of an Applegate diagram, explain how an amplification is achieved?
   (b) A two-cavity klystron amplifier has the following parameters:
   Beam voltage V_0 = 900V
   Beam current I_0=30mA
   Frequency f =8GHz
   Gap spacing in either cavity d = 1mm
   Spacing between centers of cavities L = 4cm
   Effective shunt impedance R_{sh}=40KΩ
   Determine:
   (i) The electron velocity
   (ii) The dc electron transit time
   (iii) The input voltage for a maximum output voltage
   (iv) The voltage gain in decibels

6. (a) Mention how a TWT can be converted to an oscillator? Explain the operation of such a device. How is large tuning range possible with such a device?
   (b) A Helical TWT has a diameter of 2mm with 50 turns per cm.
   Calculate the axial phase velocity and the anode voltage at which the TWT can be operated for useful gain.

7. (a) Discuss the several donation formation modes of a Gunn diode.
   (b) Mention the typical characteristics and applications of a Gunn diode.

8. (a) Give the block diagram for the measurement of impedance at microwave frequencies and explain the procedure.
   (b) Explain the principle of power measurement using Bolometric method.

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Code No: V3220 **R07** **Set No: 3**

III B.Tech. II Semester Supplementary Examinations, April/May -2013

MICROWAVE ENGINEERING

(Electronics and Communication Engineering)

Time: 3 Hours **Max Marks: 80**

Answer any FIVE Questions

All Questions carry equal marks

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1. (a) Briefly explain the following terms in rectangular waveguides.
   (i) Phase and group velocities (ii) Impedance relations
   (b) The dimensions of a guide are 2.5x1 cm. The frequency is 8.6 GHz. Find the following:
   (i) Possible modes (ii) Cutoff frequencies (iii) guide wavelength

2. (a) What are cavity resonators? Derive the equations for resonant frequencies for a rectangular and circular cavity resonators.
   (b) Calculate the resonant frequency of a circular resonator of following dimensions. Diameter = 12.5cm and length = 5cm for TM_{012} mode (consider P_{mn}=2.405 for dominant mode).
   (c) What do you understand by the quality factor of a cavity resonator? Discuss the term unloaded Q and loaded Q.

3. (a) Briefly explain the following:
   (i) Posts (ii) Turning screws (iii) Waveguide attenuators (iv) Waveguide joints
   (b) Determine the [S] of a three port circulator for a given insertion loss of 0.5dB, isolation of 20dB and VSWR of 2.

4. (a) Derive the scattering matrix for isolator, gyrator and circulator. Mention their typical applications too.
   (b) In an H-plane Tee junction, 20mW power is applied to port 3 that is perfectly matched to the junction. Calculate the power delivered to the load 60Ω and 75Ω connected to ports 1 and 2.

5. (a) List and discuss the applications and limitations of Reflex klystron and Two-cavity klystron.
   (b) A Reflex klystron oscillator has V_0=2500V, L = 6mm and f=3GHz. Calculate the repeller voltage for which the tube can oscillate in $1\frac{3}{4}$ mode and $3\frac{3}{4}$ mode.
   (c) Write a short notes on Reentrant cavities.

6. (a) What are the different slow wave structures? Explain how a helical TWT achieves amplification?
   (b) Discuss the necessity of strapping in magnetrons?

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7. (a) An IMPATT diode has a C_j of 0.05pF and L_p of 0.5nH, C_p is negligible. If the breakdown voltage is 100V and the bias current is 100mA. Determine the resonant frequency and efficiency. Assume the RF peak current as 0.8A and R_L as 2Ω.
   (b) Discuss in brief about RWH theory.
   (c) Discuss the merits and demerits of IMPATT diode.

8. (a) Briefly explain about the measurement of low and high VSWR.
   (b) How are microwave measurements different from low frequency measurements?

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Code No: V3220 **R07** **Set No: 4**

III B.Tech. II Semester Supplementary Examinations, April/May -2013

MICROWAVE ENGINEERING

(Electronics and Communication Engineering)

Time: 3 Hours **Max Marks: 80**

Answer any FIVE Questions

All Questions carry equal marks

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1. (a) Explain the typical applications of microwaves.
   (b) What do you understand by the terms cutoff wavelength, dominant mode, guide wave lengths, phase velocity, group velocity and wave impedance? Obtain the mathematical relations for each one of these and their interrelationships.

2. (a) Derive the field expressions for a rectangular cavity resonator. Plot the field patterns for the dominant mode of propagation in such a resonator for TE and TM moldes.
   (b) Calculate the lowest resonant frequency of a rectangular cavity resonator of dimensions a=2cm , b=1cm, d=3cm?
   (c) Mention one way of coupling energy to a resonator.

3. (a) Explain the action of Rat-Race junction
   (b) Discuss in detail about single hole and double hole directional coupler.
   (c) Write a short note on coupling mechanisms.

4. (a) Derive the S matrix for directional coupler.
   (b) Show that the sum of the terms of any column of the S matrix of a lossless network when multiplied by the complex conjugate of the corresponding terms of any other column is zero.

5. (a) Name the different methods of generating microwave power. Describe with necessary theory about the working of a reflex klystron oscillator. Explain how frequency stabilization is achieved in this tube?
   (b) Briefly explain the limitations and losses of conventional tubes at microwave frequencies.

6. (a) Write a brief note on the following:
   (i) π mode operation of magnetron (ii) slow wave structures
   (b) Discuss the performance of magnetrons and list the important applications.

7. (a) Explain the LSA mode of operation in a Gunn diode.
   (b) Discuss the differences between transferred electron devices and avalanche transit time devices.
   (c) What are Gunn domains?

8. (a) Give the block diagram for the measurement of attenuation at microwave frequencies and explain the procedure.
   (b) Calculate the SWR of a transmission system operating at 8GHz. The distance between two minimum power points is 0.9mm on a slotted line whose velocity factor is unity.
   (c) Briefly explain the different blocks in microwave bench setup.

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