Code No: 117FE **R13**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech IV Year I Semester Examinations, November/December - 2016
MICROWAVE ENGINEERING
(Electronics and Communication Engineering)

Time: 3 Hours **Max. Marks: 75**

Note: This question paper contains two parts A and B. Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART- A

(25 Marks)

1.a) Calculate the group and phase velocities for an angle of incidence of 33^0. [2]
b) Explain how the excitation of modes is done in rectangular waveguide? [3]
c) What is Q Factor? [2]
d) Write short notes on Waveguide Irises. [3]
e) What are the limitations of conventional vacuum tubes at microwave frequencies? [2]
f) What is the principle of working of Backward Wave Oscillator? [3]
g) What are the disadvantages of strapping? [2]
h) A magnetron has a cathode radius of 2.5 mm and an anode radius of 5 mm. What is the cut-off potential if a 0.27-Wb/m^2 magnetic field is applied? [3]
i) What is Q of a Cavity Resonator? [2]
j) Why the S-parameters are used in microwaves? [3]

PART-B

(50 Marks)

2.a) Discuss the significance and advantage of dominant mode in rectangular waveguide.
b) A rectangular waveguide with a width of 4 cm and a height of 2 cm is used to propagate an electromagnetic wave in the TE10 mode. Determine the wave impedance, phase velocity, and group velocity of the waveguide for the wavelength of 6 cm. [5+5]

OR

3.a) Distinguish between TE and TM modes of the propagation in rectangular waveguide.
b) A wave of frequency 6GHz is propagated in a parallel plane waveguide separated by 3cm. Calculate i) the cut-off wavelength for the dominant mode. ii) Wavelength in the waveguide. iii) the group and phase velocities. iv) Characteristic wave impedance. [6+4]

4.a) A 20mV signal is fed to the series arm of a lossless Magic Tee junction. Calculate the power delivered through each port when other ports are terminated with a matched load.
b) Explain coupling probes and coupling loops. [4+6]

OR

5.a) Explain the working of a two-hole directional coupler with a neat diagram and derive the expression for the coupling and directivity of a two-hole directional coupler.
b) For a directional coupler, the incident power is 550 mW. Calculate the power in the main and auxiliary arm. The coupling factor is 30 dB. [6+4]

6. Explain in detail bunching process and obtain expression for bunching parameter in a two cavity klystron. [10]

OR

7.a) The parameters of a two-cavity klystron are given by V_b = 900 V, f = 3.2 GHz, and $d = 10^{-3}$ m. Determine electron velocity, transit angle, and beam coupling coefficient.

b) Explain the principle of working of Travelling Wave Tube. [3+7]

8.a) Derive the Hartree anode Voltage equation for linear magnetron.

b) A normal circular magnetron has the following parameters: Inner radius 0.15 m, outer radius 0.45 m, Magnetic flux density 1.6 milli weber/m^2. (i) Determine Hull cut-off voltage (ii) Determine the Hull cut-off magnetic flux density if the beam voltage is 4000 V. [6+4]

OR

9.a) Explain Gunn Effect using two-valley theory? Also explain several modes of operation and applications of Gunn diodes.

b) Give the classification of solid state microwave devices. [6+4]

10.a) Find the S matrix for a matched isolator having an insertion loss of 0.5dB and isolation of 25dB.

b) Explain the S-matrix representation of a multiport microwave network and its significance. [4+6]

OR

11.a) Describe the blocks of microwave bench and their features.

b) Calculate the VSWR of a transmission system operating at 15 GHz.TE_{10} modes is propagating through the waveguide of dimensions 4.0 and 2.1 cm respectively. The distance between two successive minima is 1.5 mm. [7+3]

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Code No: 09A70402 **R09**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech IV Year I Semester Examinations, June/July - 2014
MICROWAVE ENGINEERING
(Electronics and Communication Engineering)

Time: 3 Hours **Max. Marks: 75**

Answer any Five Questions
All Questions Carry Equal Marks

- - -

1.a) Derive the TM_{mn} mode field equation in rectangular waveguide.
b) What are dominated and degenerate modes? What is the significance of dominant modes? Indicate the dominant mode in rectangular wave guide and calculate fc for the same.

2.a) Derive the expression for Rectangular cavity resonator.
b) A rectangular waveguide has dimensions 2.5 × 5 cms. Determine the guide wavelength, phase constant and phase velocity at a wavelength of 4.5 cms for dominate mode.

3.a) Explain Coupling factor , Directivity, and Isolation using Directional coupler.
b) What is meant by Microwave Attenuator? Explain the functioning of flap and vane Attenuators.

4.a) Explain E-H plane Tee junction. Why a hybrid E-H plane Tee referred to as Magic Tee .Derive the scattering matrix for all these Tees.
b) Determine the [S] matrix of a 3-port circulator given insertion loss of 0.5 dB, isolation of 20 dB, and VSWR of 2.

5.a) Draw the equivalent circuit of a reflex klystron and discuss electronic admittance in detail. Use relevant expression and plots. Mention the performance characteristics of reflex klystron?
b) Two cavity klystron is operated at 10 GHz with V_o=1200 V, I_o=30 mA, d=1 mm, L= 4 cm, and R_{sh} = 40 KΩ. Neglecting beam loading .Calculate
i) input RF voltage V_1 for a maximum output voltage,
ii) Voltage gain and iii) Efficiency

6.a) What is meant by Avalanche Transit Time Devices? Explain the operation, construction and Applications of IMPATT.
b) The helical TWT has diameter of 2 mm with 50 turns per cm. Calculate axial phase velocity and A node Voltage at which the TWT can be operated for useful gain.

7.a) Draw the neat block diagram and its operation for Attenuation measurement using power ratio method?
b) Explain the measurements of power using bolometer technique.

8. Write short notes on:
a) Gunn diode
b) Measurement of voltage standing wave ratio.

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Code No: 09A70402 **R09**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech IV Year I Semester Examinations, May/June - 2013

Microwave Engineering

(Electronics and Communication Engineering)

Time: 3 Hours **Max. Marks: 75**

Answer any Five Questions

All Questions Carry Equal Marks

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1.a) What is a Microwave spectrum bands? Explain briefly the Applications of Microwave waves at various frequency bands.

b) Explain the TE and TM modes of propagation in waveguides. Why TEM wave does not exist in rectangular wave guide. [5+10]

2.a) What are the advantages of Dominant mode of propagation in Rectangular wave guides.

b) Derive field equation for dominant TE mode of propagation in Rectangular waveguide . [5+10]

3.a) Explain the applications of Directional Couplers and Obtain scattering matrix.

b) Explain the properties of E and H-Plane Tee with neat diagram. [7+8]

4.a) What is the application of Circulator ? Derive S Matrix Calculations for Circulator with neat diagram.

b) What are different compositions and characteristics of Ferrite components? [10+5]

5.a) What is Reflex klystron Explain its operation with a neat diagram.

b) What are the limitations of conventional vacuum tubes to operate at microwave frequencies. [8+7]

6.a) What is Gunn effect. Explain the operation of Gunn diode.

b) Explain the principle of working for Two – Cavity Klystron with Velocity diagram. [8+7]

7.a) What is need of Helix in TWT? Describe the Amplification process for TWT.

b) What are Microwave Solid State Devices? Explain Operation and Applications of TED's with neat diagram [8+7]

8. Explain the following with neat diagram

a) Measurement of Microwave power

b) Measurement of VSWR [15]

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Code No: 09A70402 **R09**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech IV Year I Semester Examinations, November - 2013
Microwave Engineering
(Electronics and Communication Engineering)

Time: 3 Hours **Max. Marks: 75**

Answer any Five Questions
All Questions Carry Equal Marks

- -

1.a) Explain the wave impedance of a rectangular waveguide and derive the expression for the wave impedance of TE and TM modes.
b) Calculate the cut-off frequency of the following modes in a square waveguide 4 cm × 4 cm TE_{10}, TM_{11} and TE_{22}. [7+8]

2.a) Derive the expression for the characteristic impedance of micro strip lines.
b) Find the first five resonances of an air-filled rectangular cavity with dimensions of $a = 5$ cm, $b = 4$ cm and $c = 10$ cm ($d > a > b$). [8+7]

3.a) Explain coupling probes and coupling loops.
b) What is phase shifter? Explain its principles of operation with a neat sketch. Give its applications. [7+8]

4.a) Derive the scattering matrix of H- plane Tee?
b) What are the properties of S matrix? Derive the scattering matrix for a 3 port circulator? [7+8]

5.a) Explain the principle of operation of a two cavity klystron with a neat diagram?
b) The operating frequency of a reflex klystron is 5 GHz, it has a DC beam of 250V, a repeller spacing of 0.1 cm for $1\frac{3}{4}$ mode. Determine the maximum value of power and the corresponding repeller voltage for a beam current of 60mA. [9+6]

6.a) Explain why there are four propagation constants in TWT and derive equations to these propagation constants.
b) Explain the π mode operation of magnetron. How to separate it from other modes? [10+5]

7.a) Explain the construction of GUNN diode using RWH theory.
b) What is TRAPATT diode and explain the principle of operation? [7+8]

8.a) How to measure an attenuation of a given microwave signal?
b) What is VSWR? Explain the method measurement for low and high VSWR? [7+8]

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Code No: 117FE **R13**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech IV Year I Semester Examinations, November/December - 2016

MICROWAVE ENGINEERING

(Electronics and Communication Engineering)

Time: 3 Hours **Max. Marks: 75**

Note: This question paper contains two parts A and B. Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART- A

(25 Marks)

1.a) Calculate the group and phase velocities for an angle of incidence of 33^0. [2]

b) Explain how the excitation of modes is done in rectangular waveguide? [3]

c) What is Q Factor? [2]

d) Write short notes on Waveguide Irises. [3]

e) What are the limitations of conventional vacuum tubes at microwave frequencies? [2]

f) What is the principle of working of Backward Wave Oscillator? [3]

g) What are the disadvantages of strapping? [2]

h) A magnetron has a cathode radius of 2.5 mm and an anode radius of 5 mm. What is the cut-off potential if a 0.27-Wb/m^2 magnetic field is applied? [3]

i) What is Q of a Cavity Resonator? [2]

j) Why the S-parameters are used in microwaves? [3]

PART-B

(50 Marks)

2.a) Discuss the significance and advantage of dominant mode in rectangular waveguide.

b) A rectangular waveguide with a width of 4 cm and a height of 2 cm is used to propagate an electromagnetic wave in the TE10 mode. Determine the wave impedance, phase velocity, and group velocity of the waveguide for the wavelength of 6 cm. [5+5]

OR

3.a) Distinguish between TE and TM modes of the propagation in rectangular waveguide.

b) A wave of frequency 6GHz is propagated in a parallel plane waveguide separated by 3cm. Calculate i) the cut-off wavelength for the dominant mode. ii) Wavelength in the waveguide. iii) the group and phase velocities. iv) Characteristic wave impedance. [6+4]

4.a) A 20mV signal is fed to the series arm of a lossless Magic Tee junction. Calculate the power delivered through each port when other ports are terminated with a matched load.

b) Explain coupling probes and coupling loops. [4+6]

OR

5.a) Explain the working of a two-hole directional coupler with a neat diagram and derive the expression for the coupling and directivity of a two-hole directional coupler.

b) For a directional coupler, the incident power is 550 mW. Calculate the power in the main and auxiliary arm. The coupling factor is 30 dB. [6+4]

6. Explain in detail bunching process and obtain expression for bunching parameter in a two cavity klystron. [10]

OR

7.a) The parameters of a two-cavity klystron are given by V_b = 900 V, f = 3.2 GHz, and $d = 10^{-3}$ m. Determine electron velocity, transit angle, and beam coupling coefficient.

b) Explain the principle of working of Travelling Wave Tube. [3+7]

8.a) Derive the Hartree anode Voltage equation for linear magnetron.

b) A normal circular magnetron has the following parameters: Inner radius 0.15 m, outer radius 0.45 m, Magnetic flux density 1.6 milli weber/m^2. (i) Determine Hull cut-off voltage (ii) Determine the Hull cut-off magnetic flux density if the beam voltage is 4000 V. [6+4]

OR

9.a) Explain Gunn Effect using two-valley theory? Also explain several modes of operation and applications of Gunn diodes.

b) Give the classification of solid state microwave devices. [6+4]

10.a) Find the S matrix for a matched isolator having an insertion loss of 0.5dB and isolation of 25dB.

b) Explain the S-matrix representation of a multiport microwave network and its significance. [4+6]

OR

11.a) Describe the blocks of microwave bench and their features.

b) Calculate the VSWR of a transmission system operating at 15 GHz.TE_{10} modes is propagating through the waveguide of dimensions 4.0 and 2.1 cm respectively. The distance between two successive minima is 1.5 mm. [7+3]

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Code No: 117FE **R13**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech IV Year I Semester Examinations, April/May - 2018

MICROWAVE ENGINEERING

(Electronics and Communication Engineering)

Time: 3 Hours **Max. Marks: 75**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART- A

(25 Marks)

1.a) Draw the field pattern of TE_{10} mode in rectangular waveguide. [2]
b) Sketch microstrip line diagram and indicate important features. [3]
c) Draw the E-plane Tee junction diagram. [2]
d) Find the resonant frequency of an air-filled cavity resonator with dimensions a=5 cm, b=3=cm and d=4 cm. [3]
e) Draw typical Applegate diagram. [2]
f) Explain transit time effect in conventional tubes. [3]
g) What is mode jumping in cavity magnetron / how this can be avoided? [2]
h) Draw the diagram of IMPATT diode and carrier concentration. [3]
i) State the significance of S-Parameters at high frequencies. [2]
j) What are the possible errors in high frequency measurements? [3]

PART-B

(50 Marks)

2.a) Why TEM modes are not possible in hollow rectangular wave guides ?
b) A TE_{10} wave at 10 GHZ propagates in a rectangular wave guide of 1.5 cm × 0.6 cm dimensions filled with medium air. Determine guided wave length and wave impedance. [5+5]

OR

3. Derive the expressions for the field components due to TM waves in a rectangular waveguide. [10]

4.a) Describe the working of H-plane Tee and state why it is called shunt Tee.
b) A directional coupler is having coupling factor =10 dB and directivity = 40dB. Determine the power coupled in forward and reverse direction when input power is 10 W assuming the coupler is lossless. [5+5]

OR

5.a) With the help of diagram ,explain principles and operation of a 3-port circulator.
b) List and explain the characteristics of Ferrites. [5+5]

6.a) With the help of Applegate diagram, explain the bunching process and hence the velocity modulation in Klystron amplifier.

b) State the limitations of conventional tubes at high frequencies. [5+5]

OR

7.a) Classify the various microwave tubes with respect to the orientation of electric and magnetic fields.

b) Explain with neat sketch, the principle of operation of a TWT amplifier and write the equations for the maximum voltage gain and efficiency. [5+5]

8.a) Derive equation for Hull cut-off voltage in a Magnetron.

b) Explain the principle of operation of cavity magnetron and discuss phase focusing effect? [5+5]

OR

9.a) Discuss in detail the principle of operation of GUNN diode considering the two valley model theory and sketch its volt-ampere characteristics.

b) An n-type GaAs GUNN diode has the following specifications:

Threshold field	3kV/cm
Applied field	3.5 kV/cm
Device length	10 micrometers
Doping constant	10^{14} electrons/cm^3
Operating frequency	10 GHz

Calculate the current density (-ve) and electron mobility in the device. [5+5]

10.a) Find the S-matrix of a magic Tee.

b) Explain the double minima method of measuring VSWR. [5+5]

OR

11.a) Describe how the frequency of a given microwave source can be measured Using two different methods.

b) What are the different possible errors that will effect VSWR measurements? [5+5]

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Code No: 127FE **R15**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech IV Year I Semester Examinations, November/December - 2018
MICROWAVE ENGINEERING
(Electronics and Communication Engineering)

Time: 3 Hours **Max. Marks: 75**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART- A **(25 Marks)**

1.a) Why TEM mode is not possible for rectangular waveguides? [2]
b) A rectangular waveguide has the following values l=2.54 cm, b = 1.27 cm waveguide thickness = 0.0127. Calculate the cut-off frequency. [3]
c) What Magic is associated with a Magic Tee? [2]
d) A 20 dB coupler has a directivity of 30 dB. Calculate the value of isolation. [3]
e) What is slow wave structure? [2]
f) How oscillations are prevented in a Travelling Wave Tube? [3]
g) Write down the different types of magnetron. [2]
h) What are the Hull Cut-off and Hartree Conditions? [3]
i) Define scattering matrix. [2]
j) What is a VSWR meter and how will you determine the VSWR? [3]

PART-B **(50 Marks)**

2. Explain the wave impedance of a rectangular wave – guide and derive the expression for the wave impedance of TE, TM, and TEM mode? [10]

OR

3.a) A rectangular waveguide has the following dimensions: a=5.1cm, b=2.4cm. i) Calculate the cut-off frequency of the dominant mode. ii) Calculate the lowest frequency and determine the mode closest to the dominant mode.
b) Derive the expression for the characteristic impedance of microstrip lines. [4+6]

4.a) Incident power to a directional coupler is 80 watts. The direction coupler has coupling factor of 20 dB, directivity of 30 dB and insertion loss of 0.5 dB. Find the output power at i) main arm, ii) coupled and iii) isolated parts.
b) Explain Faraday rotation with a neat diagram. Explain the working of a ferrite isolator. [4+6]

OR

5.a) Explain the functioning of rotary vane attenuators.
b) A 30 dB directional coupler is used to sample incident and reflected power in a waveguide. The value of VSWR is 2, and the coupler sampling power = 4.5 mW. What is the value of reflected power? [6+4]

6.a) Explain about electronic and mechanical tuning of reflex klystron.

b) A TWT operates under following parameters: Beam Voltage V_o=3KV, Beam current I_o = 20 mA, characteristic Impedance of helix Z_o=10, circuit length, N=50 and frequency f =10 GHz. Determine: i) Gain parameter, ii) Output power gain in dB and iii) all Four propagation constants. [6+4]

OR

7.a) Explain how a helical TWT achieve amplification.

b) An O-type TWT operates at 2GHz. The slow wave structure has a pitch angle of 4.4^0 and attenuation constant of 2 Np/m. Determine the propagation constant of the travelling wave in the tube. [6+4]

8.a) Explain the *pi*-mode operation of magnetron.

b) A magnetron operates with following parameters: V_o = 25KV, I_o=1.25A, B_o= 0.4 wb/m^2, diameter of the cathode = 8cm, Radius of vane edge to center = 8cm. Find the cyclotron frequency and cutoff voltage. [6+4]

OR

9.a) Explain the construction of GUNN diode using RWH theory.

b) Differentiate between TEDs and transistors. [5+5]

10.a) Find the S matrix of isolator.

b) For the given scattering parameters for a two-port network calculate the equivalent impedance parameters if the characteristic impedance is 50Ω.

S_{11} = 0.4 + j0.7
$S_{12} = S_{21}$ = j0.6
S_{22} = 0.3 - j0.8 [5+5]

OR

11.a) Calculate the SWR of a transmission system operating at 8 GHz. Assume TE_{10} wave transmission inside a waveguide of dimensions a =3.5 cm, b=2.1 cm. The distance measured between twice minimum power points (successive minima) is 1 mm on a slotted line.

b) Explain how low power is measured using Bolometer technique. [4+6]

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Code No: 117FE **R13**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech IV Year I Semester Examinations, November/December - 2017
MICROWAVE ENGINEERING
(Electronics and Communication Engineering)

Time: 3 Hours **Max. Marks: 75**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

Part- A

(25 Marks)

1.a) Mention the application of waveguides. [2]
b) Write short notes on power transmission and power losses of rectangular waveguide. [3]
c) List out the functions of various waveguide components and their applications. [2]
d) Explain any one application of Magic Tee. [3]
e) Classify microwave tubes. [2]
f) Differentiate two cavity klystron and Reflex klystron. [3]
g) Explain RWH theory. [2]
h) Mention the application of TED's. [3]
i) Explain the significance of scattering matrix. [2]
j) What is the need for an isolator in MW measurements and where it is placed? [3]

Part-B

(50 Marks)

2.a) Explain why TEM mode does not exist in a circular wave guide.
b) What is the significance of Q in resonant circuits? Derive a general expression Q for a series resonant circuit. What happens to Q when circuit is loaded? [5+5]

OR

3.a) Show that TM_{01} and TM_{10} modes does not exist in a rectangular waveguide.
b) A rectangular wave guide with dimension of 8×4 cm operates in the TM11 mode at 10Ghz. Determine the characteristic wave impedance. [5+5]

4.a) What is a cavity resonator? Discuss the applications of cavity resonator.
b) Derive the expression for Q-factor of rectangular cavity. [5+5]

OR

5. Write short notes on:
a) Wave guide phase shifter b) Hybrid ring [5+5]

6.a) Draw the mode curves of Reflex klystron and derive the relation between mode number and repeller in Reflex klystron.
b) In a two-cavity klystron the parameters are, input power=10mW, voltage gain=20dB, R_{sh} of input cavity =25KΩ, R_{sh} of output cavity =35KΩ, load resistance = 40 KΩ. Find input voltage, output voltage and the power to the load. [5+5]

OR

7.a) Explain the significance of slow wave structure in the amplification process. List out the major differences between TWT and klystron.
b) Explain how amplification takes place in Helix TWT? [5+5]

8. List and explain different types of magnetrons. [10]

OR

9.a) With a neat sketch explain the structure and principle of operation of TWT amplifier.

b) How is bunching achieved in a cavity magnetron? Explain. [5+5]

10.a) Give the measurement procedure for measuring Q factor of resonant cavity.

b) Define VSWR. Describe the methods for measuring high and low VSWR's. [5+5]

OR

11.a) Explain the procedure for measuring VSWR<10.

b) Explain the procedure for measuring attenuation with neat diagram. [5+5]

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