B **R7923** **Pages: 2**

Reg No.:_______________ Name:__________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2018

Course Code: EC403

Course Name: MICROWAVE & RADAR ENGINEERING

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Explain the Transit angle effects in a conventional vacuum tube at microwave frequencies. (5)

b) Show that a coaxial re-entrant cavity support infinite number of resonant frequencies (10)

2 a) Draw the Applegate diagram with gap voltage for a reflex klystron (8)

b) A two cavity klystron amplifier has the following parameters (7)

V_0=1000 R_0=100 KΩ I_0=30mA f=5GHz

Gap spacing in either cavity d=1mm, spacing between the two cavities L=5cm

shunt impedance R_{sh}=50KΩ

a) Find the input gap voltage to give maximum voltage V_2

b) voltage gain , neglecting the beam loading in the output cavity

c) Find the efficiency of the amplifier, neglecting beam loading.

3 a) What are Cavity Resonators? Derive the equation for resonant frequency for a rectangular cavity resonator (5)

b) Draw the structure of 8 cavity magnetron and explain its bunching process. (10)

PART B

Answer any two full questions, each carries 15 marks.

4 a) Explain the various types of slow wave structures. (5)

b) A helix travelling wave tube operates at 4 GHz, under a beam voltage of 10 KV and beams current of 500mA. If the helix is 25Ω and interaction length is 20cm, find the gain parameter. (10)

5 a) Define the S matrix of a two port network. Represent the logical variables used mathematically and with the aid of a figure. (5)

b) Based on the principle of working list the different types of wave meters used for measurement of microwave frequency. With a diagram explain the method of measurement of frequency with any one type of wave meter. (10)

6 a) Determine the coupling, directivity and isolation (in dBs) of a lossless directional coupler carrying the following: Incident power: 40mW, power at the coupling port: 10mW, and power at the decoupled port: 0.1mW. (5)

b) Derive the expression for axial electric field in the TWT. (10)

PART C

Answer any two full questions, each carries 20 marks.

7 a) Compare the peak power levels achieved by microwave diodes (5)

b) A typical n-type GaAs Gunn diode has the following parameters .Threshold field E_{th}=2800V/cm, Applied field E=3200V/cm, Device Length L=10µm, Doping concentration $n_o=2x10^{14}cm^{-3}$, operating frequency f=10GHz. (7)

a) Compute electron drift velocity.

b) Calculate current density

c) Estimate negative electron mobility

c) What are the main assumptions made in power frequency limitations and what are the power frequency limitations of a microwave transistor? (8)

8 a) List the difference between microwave transistors and TEDs. (5)

b) With neat diagram explain series and parallel loading in tunnel diode. (7)

c) Describe the Ridley -Watkins -Hilsum theory and derive the condition for negative resistance. (8)

9 a) What are the different geometries of microwave power transistor and their figure of merit (5)

b) Explain with neat diagram, the working of CW radar with non zero IF. (7)

c) (i) Show that how the tunnel diode can be utilized as bistable, astable, monostable circuits. (4)

(ii) A tunnel diode can realize a negative resistance amplifier? Justify your answer (4)

****

B **G1025** **Pages: 2**

Reg No.:_______________ Name:__________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION(S), MAY 2019

Course Code: EC403

Course Name: MICROWAVE & RADAR ENGINEERING

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Explain the significance of re-entrant cavities in microwave tubes. What are the different types of re-entrant cavities? (5)

b) With the help of a schematic structural diagram explain the working of a two cavity Klystron Amplifier. Also give its typical specifications. (10)

2 a) How oscillation generate in reflex klystron? (5)

b) With the help of applegate diagram describe the bunching process of two cavity klystron amplifier and derive the bunching parameter also. (10)

3 a) A reflex Klystron operates under following Conditions: (5)

V_0= 600V, Length L=1mm, R_{sh} =15KΩ, e/m =1.759x10^{11}, f_r =9GHz

The tube is oscillating at f_r at the peak of the n= 2 mode or $1\frac{3}{4}$ mode.

Assume that the transit time through the gap and beam loading can be neglected.

a) Find the value of the repeller voltage V_R

b) Find the direct current necessary to give a microwave gap voltage of 200V

c)What is the electronic efficiency under this condition?

b) Define Velocity modulation and how velocity modulation changes to current density modulation in Klystron Amplifier:- (10)

PART B

Answer any two full questions, each carries 15 marks.

4 a) What are different types of waves generated in a TWT after interaction with electron beam and RF signal:-. (5)

b) A travelling wave tube (TWT) operates under the following parameters: Beam voltage, V_0=3kV; Beam current, I_0=30mA; Characteristics of helix,Z_0=10Ω; Circuit length, N=50; Frequency, f=10GHz. Determine: (a) the gain parameter, C (b) the output power gain, A_p in decibels and (c) all four propagation constants. (10)

5 a) Draw the block diagram of a typical microwave bench setup and label all the (5)

parts. What are the parameters that can be measured using the setup?

b) With a schematic describe the operation of a four port circulator. Obtain the simplified S matrix of a perfectly matched, lossless four port circulator (10)

6 a) Show that the magnitude of the velocity fluctuation of the electron beam is directly proportional to the magnitude of the axial electric field in a helix TWT (5)

b) Derive the expression of scattering matrix for directional coupler. (10)

PART C

Answer any two full questions, each carries 20 marks.

7 a) Derive the minimum detectable signal of a RADAR (5)

b) a) A certain silicon microwave transistor has the following parameters. (7)

Reactance X_c=1Ω, Transit time cut off frequency f_r=4GHz, Maximum electric field E_{m}=1.6x10^5V/cm, Saturation drift velocity V_s=4x10^5cm/s. Determine the maximum allowable power transistor can carry.

b) How tunnel diode can be used as circulator.

c) What are low noise front ends? Describe in detail the utility of low noise front ends. (8)

8 a) What is Doppler effect. Derive the equation for doppler efficiency. (5)

b) Explain in detail the principle of a GUNN diode. Draw the I V characteristics. (7)

c) Derive the Radar range equation. (8)

9 a) Explain the basic principles of radar system. (5)

b) (i) Show that the product of the maximum unambiguous range R_{un} and the first blind speed ν_1 is equal to c λ/4. (3)

(ii) A guided missile tracking radar has the following specifications (4)

Transmitted Power = 400 kW ; Pulse repetition frequency = 1500 pps ; Pulse width = 0.8 μsec

Determine Unambiguous range, Duty cycle, Average power and suitable bandwidth of the radar.

c) (i) Prove that decrease in drift velocity with increasing electric field can lead to the formation of a high field domain for microwave generation and amplification:- (5)

(ii) A certain silicon microwave transistor has the following parameters:

Reactance = 1Ω, Transit-time cut off frequency = 4 GHz, (3)

Maximum electric field = 1.6 × 10^5 V/cm, Saturation drift velocity = 4 × 10^5 cm/s. Determine the maximum power that the transistor can carry

****

Reg No.:_______________ Name:__________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION(R&S), DECEMBER 2019

Course Code: EC403

Course Name: MICROWAVE & RADAR ENGINEERING

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Derive the resonant frequency of a rectangular cavity resonator. (4)

b) Determine the resonant frequency of an air filled rectangular cavity operating in the dominant mode with dimensions as a=4cm, b=5cm and d=6cm. (3)

c) Assuming pi mode of oscillations explain how a magnetron can sustain its oscillations using the cross field. (8)

2 a) With the help of Applegate diagram describe the bunching process in a two cavity klystron amplifier and derive the bunching parameter. (8)

b) A reflex klystron operates under the following conditions: (7)

V_o=500V, R_{sh} =10KΩ, f_r= 8 GHz, L =1 mm, e/m = l.759 x 10^{11} (MKS system)

The tube is oscillating at f_r at the peak of the n = 2 or $1\frac{3}{4}$ mode. Assume that the transit time through the gap and beam loading to be neglected. Determine:-

1. The value of the repeller voltage Vr.
2. The direct current necessary to give a microwave gap voltage of 200 V.
3. The electronic efficiency under this condition.

3 a) Explain the electronic admittance of the gap in the case of reflex klystron. With admittance diagram explain the condition required for oscillation in a reflex Klystron. (7)

b) Given the parameters of a two cavity klystron amplifier: (8)

Beam Voltage = 1000V,
Beam current = 50mA,
Operating frequency = 10GHz
Gap spacing=1mm,
Spacing between two cavities = 5cm,
Ro= 40KΩ, Rs = 30KΩ

Determine:

1. Input signal to generate maximum output voltage.
2. Voltage gain.
3. Efficiency.

PART B

Answer any two full questions, each carries 15 marks.

4 a) With neat diagrams explain any two methods to measure impedance at microwave frequencies. (8)

b) Explain with figure a two hole directional coupler and derive its S matrix. (7)

5 a) With neat diagram explain the operation of a travelling wave tube. (7)

b) Discuss the constructional features of magic tees and derive its S Matrix. Why are they called so? (8)

6 a) Derive the expression of axial electric field of Helix TWT. (8)

b) With a schematic describe the operation of a four port circulator. Obtain the simplified S matrix of a perfectly matched, lossless four port circulator. (7)

PART C

Answer any two full questions, each carries 20 marks.

7 a) What is tunnelling? Explain the operation of a tunnel diode with aid of energy band diagram. (10)

b) Derive Radar range equation. (5)

c) A simple MTI delay line canceller is an example of time domain filter. Explain Why? (5)

8 a) Discuss the various limitations of microwave transistors. (10)

b) Explain the more commonly used radar displays. (5)

c) Explain how the noise figure of a radar receiver is monitored. (5)

9 a) Explain with neat diagram, the working of CW radar with non zero IF. (10)

b) Explain with the help of figures different modes of operation of Gunn diodes. (10)

****

Reg No.:_______________ **00000EC403121904** Name:__________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Seventh semester B.Tech degree examinations (S), September 2020

Course Code: EC403

Course Name: MICROWAVE & RADAR ENGINEERING

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) What are re-entrant cavities? Show that they support infinite number of resonant frequencies. (7)

b) Derive power output and efficiency of a reflex klystron. (8)

2 a) A reflex klystron operates under the following conditions: (8)

$V_0 = 600V$, $R_{sh} = 15K\Omega$, $f_r = 9$ GHz, L =1 mm, e/m = 1.759 x 10^{11} (MKS system)

The tube is oscillating at fr at the peak of the n = 2 or $1\frac{3}{4}$ mode. Assume that the transit time through the gap and beam loading to be neglected. Determine:-

1. The value of the repeller voltage Vr.
2. The direct current necessary to give a microwave gap voltage of 200 V.
3. The electronic efficiency under this condition.

b) Derive an expression for velocity modulation in two cavity Klystron with the help of a neat diagram. (7)

3 a) A two cavity klystron amplifier has the following parameters: (8)

V_0=700V R_o=100 kΩ I_o=30mA f =3GHz

Gap spacing in either cavity d=1mm, spacing between the two cavities L=5cm and shunt impedance R_{sh}=30kΩ.

Determine:

1. Input gap voltage to give maximum voltage V_2
2. Voltage gain , neglecting the beam loading in the output cavity
3. Efficiency of the amplifier, neglecting beam loading.
4. Beam loading conductance and show that it can be neglected.

b) With the help of neat sketches and sufficient equations explain the working of a cylindrical magnetron. (7)

PART B

Answer any two full questions, each carries 15 marks.

4 a) Show that the axial electric field of TWT varies with convection current (8)

b) Explain the constructional features of two hole directional coupler and derive S matrix (7)

5 a) Explain the different methods used for measuring microwave frequency. (7)

b) Explain how isolators can support only forward direction waves. (8)

6 a) What is the significance of slow wave structures used in microwave circuits? Explain different slow wave structures with neat sketches. (8)

b) With a schematic describe the operation of a four port circulator. Obtain the simplified S matrix of a perfectly matched, lossless four port circulator. (7)

PART C

Answer any two full questions, each carries 20 marks.

7 a) Explain with block diagram an FM-CW Radar using sideband super heterodyne receiver (10)

b) Draw the J-E characteristics of Gunn diode and explain its operation. (10)

8 a) What are the main assumptions made in power frequency limitations? Explain the power frequency limitations of a microwave transistor. (10)

b) What are low noise front ends? Describe in detail the utility of low noise front ends. (10)

9 a) Explain with block diagram the working of MTI Radar with power amplifier and power oscillator (10)

b) Draw the energy band diagrams of tunnel diode. Explain the operation of tunnel diode with the help of I-V characteristics. (10)

****

Reg No.:_______________ Name:__________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Seventh Semester B.Tech Degree Examination (Regular and Supplementary), December 2020

Course Code: EC403

Course Name: MICROWAVE & RADAR ENGINEERING

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Explain with figure rectangular waveguide resonator. Derive the resonant frequency of rectangular cavity resonator. (8)

b) With the help of figures explain the bunching process of an 8-cavity cylindrical magnetron. (7)

2 a) Given the parameters of a two-cavity klystron amplifier: (8)

Beam Voltage = 1000V, Beam current = 50mA, Operating frequency = 10GHz, Gap spacing=1mm, Spacing between two cavities = 5cm, R_o= 40KΩ, R_s = 30KΩ

Calculate

a. Input signal to generate maximum output voltage
b. Voltage gain
c. Efficiency

b) With admittance diagram explain the condition required for oscillation in a reflex Klystron. (7)

3 a) Explain how velocity modulation changes to current density modulation in Klystron amplifier. (7)

b) The parameters associated with a reflex klystron oscillator are: (8)

V_0 =800V, R_{sh} =25KΩ, f_r= 15 GHz, L =1.5 mm, e/m = l.759 x 10^{11} (MKS system). The tube is oscillating at n = 2 mode or $1\,{}^{3}/_{4}$ mode. Assume that the transit time through the gap and beam loading can be neglected.

Determine

a) The value of the repeller voltage V_r.
b) The direct current necessary to give a microwave gap voltage of 200 V.
c) The electronic efficiency under this condition.

PART B

Answer any two full questions, each carries 15 marks.

4	a)	Explain the amplification process of Travelling Wave Tubes (TWT) and define its gain parameter.	(7)
	b)	Explain the constructional features of two-hole directional coupler and derive S Matrix.	(8)
5	a)	Explain how impedances are measured using slotted line and reflectometer.	(8)
	b)	Define a microwave junction. Deduce the scattering matrix relation between the input and output of an n X n junction starting with an analogy of a transmission line.	(7)
6	a)	Show that the magnitude of the velocity fluctuation of the electron beam is directly proportional to the magnitude of the axial electric field in a helix TWT.	(8)
	b)	Explain with figure a ferrite isolator can support only forward direction waves.	(7)

PART C

Answer any two full questions, each carries 20 marks.

7	a)	Discuss the various limitations of microwave transistors. What are the main assumptions made in power frequency limitations?	(10)
	b)	Explain with block diagram the principle of operation of a pulsed Radar.	(10)
8	a)	Prove that decrease in drift velocity with increasing electric field can lead to the formation of a high field domain for microwave generation and amplification.	(10)
	b)	Explain low noise front ends? Describe in detail the utility of low noise front ends.	(10)
9	a)	With neat diagram explain serial loading and parallel loading in tunnel diode. How tunnel diode can be used as an oscillator?	(10)
	b)	Explain the operation of commonly used Radar displays.	(10)

****