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 v_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,
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 (3)

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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)

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