APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Scheme for Valuation/Answer Key

Scheme of evaluation (marks in brackets) and answers of problems/key

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

Course Code: EC403

Course Name: MICROWAVE & RADARENGINEERING

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 (3)
What are the different types of re-entrant cavities? (2)

b) Schematic structural diagram of two cavity klystron (3)
Working of a two cavity Klystron Amplifier. (4)
Also give its typical specifications. (3)

2 a) How oscillation generate in reflex klystron?
Applegate diagram (2)
Working (3)

b) With the help of applegate diagram describe the bunching process of two cavity klystron amplifier and derive the bunching parameter also. (2)
Applegate (4)
Working (4)
Bunching parameters

3 a) A reflex Klystron operates under following Conditions: (1)
V_0= 600V, Length L=1mm, R_{sh} =15KΩ, e/m =1.759x10^{11}, f_r =9GHz (2)
The tube is oscillating at f_r at the peak of the n= 2 mode or 1$_{34}$ mode. Assume that the transit time through the gap and beam loading can be neglected. (2)
a) Find the value of the repeller voltage VR
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:- (2)
Definition (2)
Diagram (6)
Working

PART B

Answer any two full questions, each carries 15 marks.

4 a) What are different types of waves generated in a TWT (2)
Interaction with electron beam and RF signal (TWT working):-. (3)

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: (3)
(a) the gain parameter, C
(b) the output power gain, A_p in decibels and (4)

(c) all four propagation constants.

5 a) Draw the block diagram of a typical microwave bench setup and label all the parts. What are the parameters that can be measured using the setup? (3)
Block diagram (2)
Parameters

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 (2)
Diagram (4)
Operation (4)
S-Matrix

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 - Derivation (7)
Final matrix (3)

PART C

Answer any two full questions, each carries 20 marks.

7 a) Derive the minimum detectable signal of a RADAR (2)
SNR equation (3)
MDS equation

b) a) A certain silicon microwave transistor has the following parameters.
Reactance X_c=1Ω, Transit time cut off frequency f_t=4GHz, Maximum electric field E_m=1.6x10^{5}V/cm, Saturation drift velocity V_s=4x10^{5}cm/s. Determine the maximum allowable power transistor can carry. (4)
b) How tunnel diode can be used as circulator. (3)

c) What are low noise front ends? (4)
Describe in detail the utility of low noise front ends. (4)

8 a) What is Doppler effect. (2)
Derive the equation for doppler efficiency. (3)

b) Explain in detail the principle of a GUNN diode. Draw the I V characteristics. (2)
Diagram (3)
Principle
I V characteristics (2)

c) Derive the Radar range equation. (2)
Power density (3)
Power received
Range equation (3)

9 a) Explain the basic principles of radar system. (2)
Diagram (3)
principle

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.
(ii) A guided missile tracking radar has the following specifications
Transmitted Power = 400 kW ; Pulse repetition frequency = 1500 pps ; Pulse width = 0.8 μsec (3)

Determine Unambiguous range, Duty cycle, Average power and suitable bandwidth of the radar. (4)

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: (3)
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

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