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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)
 $V_0 = 600\text{V}$, Length $L = 1\text{mm}$, $R_{sh} = 15\text{K}\Omega$, $e/m = 1.759 \times 10^{11}$, $f_r = 9\text{GHz}$
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, $V_0 = 3\text{kV}$; Beam current, $I_0 = 30\text{mA}$; Characteristics of helix, $Z_0 = 10\Omega$; Circuit length, $N = 50$; Frequency, $f = 10\text{GHz}$. 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 $X_c = 1\Omega$, Transit time cut off frequency $f_r = 4\text{GHz}$, Maximum electric field $E_m = 1.6 \times 10^5 \text{V/cm}$, Saturation drift velocity $V_s = 4 \times 10^5 \text{cm/s}$. 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 $c \lambda/4$. (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: (3)
Reactance = 1Ω , Transit-time cut off frequency = 4 GHz,
Maximum electric field = $1.6 \times 10^5 \text{V/cm}$, Saturation drift velocity = $4 \times 10^5 \text{cm/s}$. Determine the maximum power that the transistor can carry
