Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Seventh Semester B.Tech Degree Regular and Supplementary Examination December 2021 (2015 Scheme)

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 how the gap transit angle of a two-cavity klystron tube controls the coupling coefficient? (4)

b) A rectangular cavity resonator has dimension of a=4cm, b=2cm and d=8cm. Compute the resonant frequency of an air-filled rectangular cavity operating in the dominant mode. (3)

c) Explain with the help of necessary diagrams how the electron bunching occurs in cylindrical magnetron? (8)

2 a) With the help of Applegate diagram explain the bunching process in a two-cavity klystron amplifier. Derive the bunching parameter. (8)

b) A reflex klystron operates under the following conditions: V_o=700V, R_{sh} =12KΩ, f_r= 9.3 GHz, L =1 mm, e/m = l.759 x 1011 (MKS system) (7)

The tube is oscillating at f_r at the peak of the n = 2 or 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 180 V.
3. The electronic efficiency under this condition

3 a) A two-cavity klystron amplifier has the following parameters: V_0 =900V, R_o=120kΩ, I_o=30mA, f=3GHz Gap spacing in either cavity is d=1mm, spacing between the two cavities L=5cm and shunt impedance R_{sh} =20kΩ. (8)

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) Derive the output power and efficiency of a reflex klystron oscillator. (7)

PART B

Answer any two full questions, each carries 15 marks.

4 a) Explain slow wave structures. Describe how the slow wave structure of a TWT helps in bunching process. (8)

b) Define the terms coupling coefficient (C), directivity (D) and isolation (I) of a directional coupler. Determine these parameters in DB for a lossless directional coupler with incident power 40mw, power at the coupling port is 10mw and power at the decoupled port 0.1 mw. (7)

5 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 (7)

b) Define S matrix. Explain the properties of S matrix. (3)

c) Explain the constructional features of magic tees and derive its S Matrix (5)

6 a) Explain different methods for measuring microwave power. (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 Ridley–Watkins–Hilsum theory with the help of two valley model and derive the conditions for negative resistance. (10)

b) Show that the product of the maximum unambiguous range R_{un} and the first blind speed V_1 is equal to $c\lambda/4$. (5)

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

8 a) Why the low noise front ends are necessary for a radar receiver? Describe the utility of low noise front ends. (10)

b) Explain the various limitations of microwave transistors. What are the main assumptions made in power frequency limitations? (10)

9 a) With neat diagram explain serial loading and parallel loading in tunnel diode. How tunnel diode can be used as circulator? (10)

b) Explain FM-CW Radar with the help of a block diagram (10)

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