MACHAKOS UNIVERSITY

University Examination 2018/2019
SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
FIFTH YEAR SECOND SEMESTER EXAMINATION FOR
BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONICS ENGINEERING)
EEE 547 MICROWAVE ENGINEERING

DATE: 21/5/2019 **TIME: 8.30-10.30 AM**

INSTRUCTIONS

Answer question one and any other two

QUESTION ONE (30 MARKS)

a) Explain why Scattering parameters are preferred to the other network analysis parameters (3 marks)

b) Differentiate between Symmetrical, Reciprocal and Lossless networks (3 marks)

c) Derive the S-parameters for a 2-port network (8 marks)

d) A microwave antenna feed network operating at 5 GHz requires a 50Ω printed transmission line that is 16λ long. Possible choices are:

(8 marks)

i. Copper microstrip, with d = 0.16 cm, $\epsilon_r = 2.20$ and $tan\ \delta = 0.001$, or

ii. Copper stripline, with b = 0.32 cm, $\epsilon_r = 2.20$, $t = 0.01$ mm and $tan\ \delta = 0.001$.

Which line should be used, if the attenuation is to be minimized? The conductivity loss is $\sigma = 5.813 \times 10^7$ S/m.

e) A reflex kystron operates at 8GHz at the peak of n=2 mode with V_0=300 V, Rsh=20 kΩ, L = 1mm. If the gap transit time and beam loading are neglected, calculate: (8 marks)

i. repeller voltage

ii. beam current necessary to obtain RF gap voltage of 200 V

iii. electronic efficiency

QUESTION TWO (20 MARKS)

a) Within the scope of microwave strip lines, briefly explain the following: (16 marks)

i. Microstrip

ii. Parallel

iii. Shielded

iv. Coplanar

Use appropriate illustrations

b) Explain how microwave oven works (4 marks)

QUESTION THREE (20 MARKS)

a) A two port network is known to have the following scattering matrix: (14 marks)

$$[S]=\begin{bmatrix} 0.15\angle 0^\circ & 0.85\angle -40^\circ \\ 0.85\angle 40^\circ & 0.20\angle 0^\circ \end{bmatrix}$$

i. Determine if the network is reciprocal and lossless.

ii. If the port two is terminated with a matched load, what is the return loss seen at port 1?

iii. If the port two is terminated with a short circuit, what is the return loss seen at port 1?

b) Explain the biological effects and safety of exposure to microwave radiation (6 marks)

QUESTION FOUR (20 MARKS)

a) Explain why for high-frequency applications, the n-p-n structure of a BJT is preferred (3 marks)

b) Discuss tree limitation that affect the performance of a BJT at microwave frequencies (9 marks)

c) A certain silicon microwave transistor has the following parameters: (4 marks)

Reactance: $X_C=1\Omega$

Transit-time cutoff frequency: f_r= 4 GHz

Maximum electric field: $E_m = 1.6 \times 10^5$ V/cm

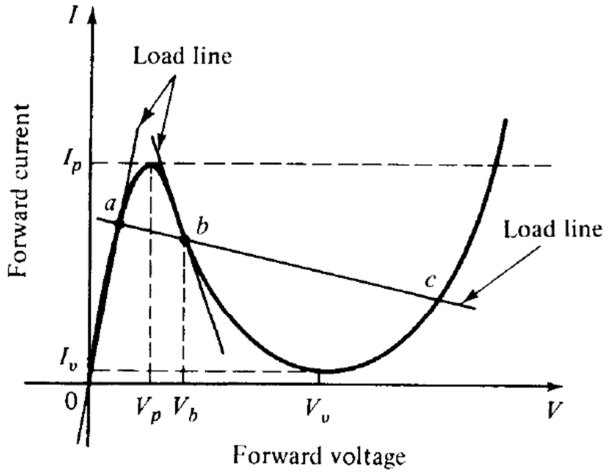
Saturation drift velocity: $V_S = 4 \times 10^5$ cm/s

Determine the maximum allowable power that the transistor can carry.

d) Differentiate between Microwave Linear-Beam Tubes and Microwave Crossed-Field Tubes (4 marks)

QUESTION FIVE (20 MARKS)

a) With reference to the below IV characteristics, explain the operation modes of a tunnel diode at microwave frequencies (10 marks)



b) An X-band pulsed conventional magnetron has the following operating parameters: (10 marks)

Anode voltage:	$V_0 = 5.5$ kV
Beam current:	$I_0 = 4.5$ A
Operating frequency:	$f = 9 \times 10^9$ Hz
Resonator conductance:	$G_r = 2 \times 10^{-4}$ mho
Loaded conductance:	$G_\ell = 2.5 \times 10^{-5}$ mho
Vane capacitance:	$C = 2.5$ pF
Duty cycle:	$DC = 0.002$
Power loss:	$P_{loss} = 18.50$ kW

Determine

i. The angular resonant frequency

ii. The unloaded quality factor

iii. The loaded quality factor

iv. The external quality factor