MACHAKOS UNIVERSITY

University Examinations for 2021/2022

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

FIFTH YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONICS ENGINEERING)

EEE 547: MICROWAVE ENGINEERING

DATE: **TIME:**

INSTRUCTIONS

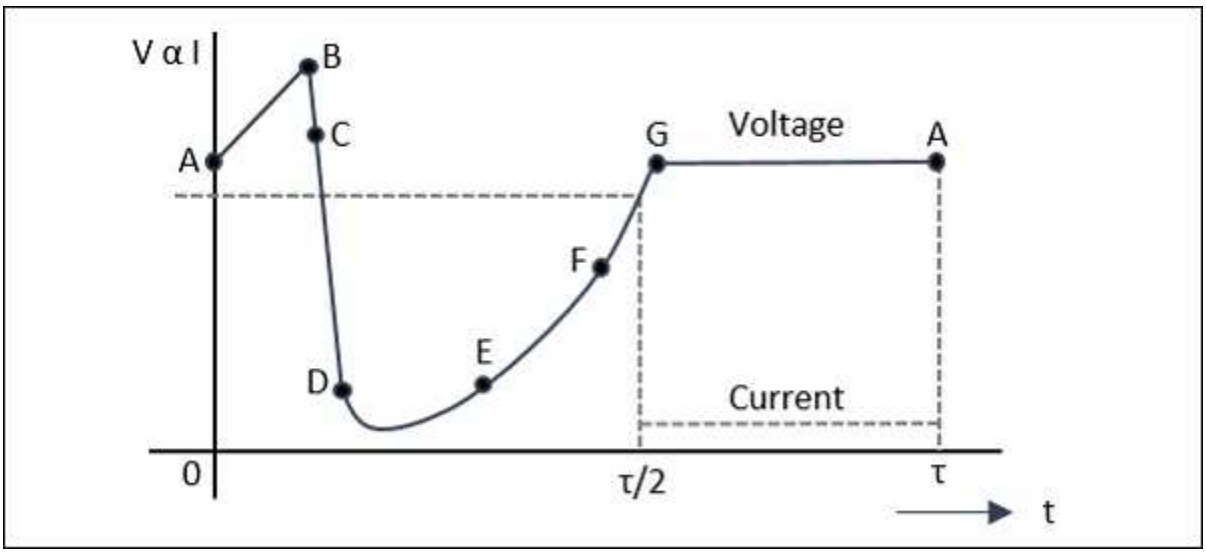
Answer Question One and Any Other Two Questions

QUESTION ONE (COMPULSORY) (30 MARKS)

a) Explain five main properties of Microwaves. **5mks**

b) Using appropriate diagram, explain the differences between a strip line and a slot line transmission lines **6mks**

c) The following diagram shows the different behaviour of voltage against time for a TRAPATT diode. Explain the different stages. **9mks**



d) Using a well labelled diagram, discuss the GUNN diode voltage current characteristics. Explain the two modes of negative resistance operation **10mks**

QUESTION TWO (20 MARKS)

(a) A microwave antenna feed network operating at 5 GHz requires a 50Ω printed transmission line that is 16λ long. Possible choices are: **9mks**

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 $\sigma = 5.813\times10^7$ S/m.

(b) 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: **8mks**

i. repeller voltage

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

iii. electronic efficiency

(c) Explain three differences between Isolator and Circulator **3mks**

QUESTION THREE (20 MARKS)

(a) A two-port network is known to have the following scattering parameters: **6mks**

$$[S]=\begin{bmatrix} 0.15 < 0° & 0.85 < -45° \\ 0.85 < 45° & 0.2 < 0° \end{bmatrix}$$

Determine if the network is reciprocal and lossless

(b) Discuss Tee Junction under the following title **[4mks**

(i) Definition

(ii) Types

*(iii)*Construction of each type

(iv) Operation of each type

(v) S-Matrix of each

QUESTION FOUR (20 MARKS)

(a) Explain in detail about 2-cavity klystron amplifier. **14mks**

(i) schematic circuit diagram
(ii) mechanism of operation
*(iii)*velocity modulation process
(iv) bunching process
(v) Calculation of efficiency, mutual conductance and voltage gain.

(b) A typical n-type GaAs Gunn diode has the following parameters **6mks**

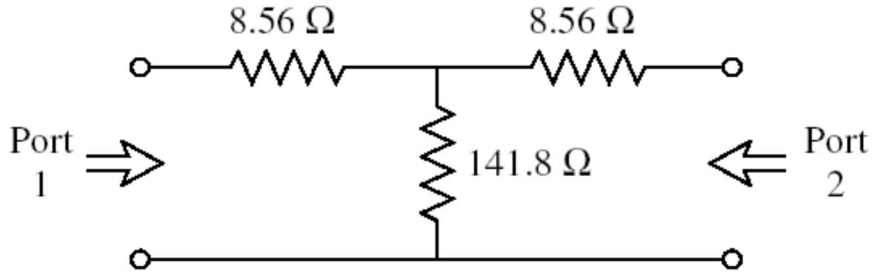
Eh=2800V/cm E=3200V/cm L=10μm $n_o = 2\times10^{14}$cm f=10GHz

(i) Compute the electron drift velocity
(ii) Calculate the current density
*(iii)*Estimate the negative electron mobility

Question five (20 marks)

(a) Explain 5 advantages of TWT **6mks**

(b) Find the *S* parameters of the 3 dB attenuator circuit shown in the figure below **8mks**



(c) Two identical **30dB** directional couplers are used to sample incident and reflected power in a waveguide. The value of VSWR is **6** and the output of the coupler sampling incident power is **5mw**. Determine the value of the reflected power. **6mks**