MACHAKOS UNIVERSITY

University Examinations for 2023/2024 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

FIFTH YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING

EEE 547: MICROWAVE ENGINEERING

DATE: **TIME:**

INSTRUCTIONS

QUESTION ONE (COMPULSORY)

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

(b) Design an air-filled circular waveguide yielding a frequency separation of 1 GHz between the cutoff frequencies of the dominant mode and the next highest mode. **12marks**

(c) Two identical 30dB directional couplers are used to sample incident and reflected power in a waveguide. The VSWR = 2 and the output of the coupler sampling incident power gave 4.5mW. Determine the value of the reflected power **8marks**

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: **9marks**

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

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

(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: **8marks**

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 **3marks**

QUESTION THREE (20 MARKS)

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

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

Determine if the network is reciprocal and lossless

(b) Discuss Tee Junction under the following title **14marks**

(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. **14marks**

(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 **6marks**

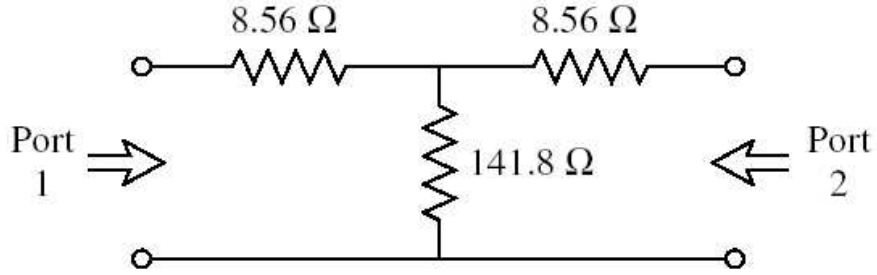
Eh=2800V/cm E=3200V/cm L=10μm $n_o=2\times10^{14}$cm f=10GHz

(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 **6marks**

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



(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. **6marks**