Kafrelsheikh University
Faculty of Engineering
Dept. Electrical Engineering
Year: 4th Year communication
Subject: Microwave Electronic Engineering
(ECE4115)

Semester: 1st Semester
Final Examination
Date: Jan. 1st, 2018
Time allowed: 3 hours.

Full Mark: 90

(a) This exam measures ILOs no.: a.3, a. 5, a.14 a.15, a.20, b.6, b.13, C.1, c.5, C.15, d.1.
(b) No. of pages: 2 - No. of questions:5
(c) Ask for clarification if any question statement is not clear to you, (answer as possible as).

## Question # 1 (18Marks)

1. Identify the high frequency limitations of conventional tubes and how these limitations are improved by microwaves tubes (4Marks).
2. What should be the spacing between the buncher and the catcher cavities in order to achieve a max degree of bunching, with analysis? Give the drawbacks of klystron amplifiers. (7Marks).
3. The parameters of a two-cavity amplifier klystron are as follows: (7Marks).

Beam voltage 1200 v, Beam current 28mA, Frequency 8 GHz, Gap spacing in either cavity 1 mm, Spacing between the two cavities 4cm, Effective shunt resistance 40 kΩ (excluding beam loading)

a. Find the input microwave voltage *Vi* in order to generate a maximum output voltage *V2* (including the finite transit-time effect through the cavities).
b. Determine the voltage gain (neglecting the beam loading in the output cavity).
c. Calculate the efficiency of the amplifier (neglecting the beam loading}.
d. Compute the beam loading conductance and show that one may neglect it in the preceding calculations.

## Question # 2 (18 Marks)

1. Explain the operating principle of reflex klystron, clarify the flowing, Why do different modes of operation exist for a reflex and How does bunching occur in a reflex klystron? What are the assumptions for calculation of RF power in Reflex Klystron? (6Marks).
2. Drive an expression for the round trip transit time in the repeller region "T′" of the reflex klystron cavity. (6Marks).
3. A two-cavity klystron amplifier has the following parameters: (6Marks).

Beam voltage 30Kv, Beam current 3A, Operating frequency 10GHz, Beam coupling coefficient $\beta_0=\beta_i= 1$, dc electron charge density $10^{-7}$ c/m$^3$, Signal voltage 15v(rms), Cavity shunt resistance 1kΩ, Total shunt resistance including load10 kΩ. Calculate:

a. The plasma frequency
b. The reduced plasma frequency for $R = 0.4$
c. The induced current in the output cavity
d. The induced voltage in the output cavity
e. The output power delivered to the load
f. The power gain
g. The electronic efficiency

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With my best wishes Dr. noha abd al salam al shalaby and committee of correctors and testers

## Question # 3 (17 Marks)

1. Sketch the TWT diagram, clarify the flowing, what is the purpose of slow wave structures used in TWT amplifiers? How are spurious oscillations generated in TWT amplifier? State the method to suppress it. (7Marks).
2. A reflex klystron operates at the peak of the $n = 2$ mode. The de power input is 40 mW and $Vi/Vo = 0.278$. If 20% of the power delivered by the beam is dissipated in the cavity walls, find the power delivered to the load. (5Marks).
3. A traveling-wave tube (TWT) has the following characteristics: (5Marks).

Beam voltage 2.5kv, Beam current 50mA, Frequency 8GHz, Circuit length, N=45 Characteristic impedance 6.75 Ω Determine:

a. The gain parameter C
b. The output power *AP* gain in decibels
c. All four propagation constants
d. The wave equations for all four modes in exponential form

## Question # 4 (17 Marks)

1. Explain the principle operation of the magnetron cavity, (Sketch the diagram), what is the magnetron operation mode and How ensure to operate in it? (6Marks).
2. An Amplitron operates under the following parameters: Operating frequency 9 GHz, Anode voltage20 kV, Anode current 20 kV, Magnetic flux density 0.3 $Wb/m^2$, Characteristic impedance 50Ω. Compute: (5Marks).
   a. The de electron-beam velocity
   b. The electron-beam phase constant
   c. The cyclotron angular frequency
   d. The cyclotron phase constant
   e. The gain parameter
3. List the types of backward wave oscillator "BWO", then explain the principle operation of any one of them (Sketch the diagram). (6Marks).

## Question # 5 (20Marks)

1. Describe the operation of GUNN diode, and show how tuning it. (4Marks).
2. Explain the principle operation of tunnel diode with sketch the energy band diagram. (4Marks).
3. Drive an expression for the power gain of the tunnel diode amplifier when connected it parallel with a resistive load? How convert it to oscillator system. (4Marks).
4. How connected tunnel diode to a microwave circulator to make a negative resistance amplifier? (3Marks).
5. Explain the working principle of IMPATT diode comparing with PIN and shottkey diodes, and then identify the avalanche multiplication. (5Marks).

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