Code No: R05320403

Set No. 1

III B.Tech II Semester Regular Examinations, Apr/May 2008
MICROWAVE ENGINEERING
(Common to Electronics & Communication Engineering and Electronics & Telematics)

Time: 3 hours   Max Marks: 80

Answer any FIVE Questions
All Questions carry equal marks
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1. (a) Derive the expression for guide wave length of TE_{mn} mode in rectangular wave guide.
   (b) What are the advantages of dominant mode propagation?   [8+8]

2. (a) What are TE_{nm} and TM_{nm} modes w.r.t a circular wave guide. Sketch the dominant modes.
   (b) A cylindrical wave guide has a inner radius of 2 cm. Find the cut off frequency for the guide operating in TE_{11} mode. Calculate λ g and Z_{TE} at 10 GHz (λ_0 = 3 cm).   [8+8]

3. Write short notes on:
   (a) Wave guide Irises
   (b) Rat ? Race hybrid
   (c) Dielectric phase shifters.   [16]

4. (a) Explain the characteristics of ferrite materials.
   (b) Derive the S - matrix for 4 port directional coupler when the coupling factor is 3dB.   [8+8]

5. (a) A reflex klystron operates under the following conditions:
   $V_0 = 300v$, $I_0 = 11.45mA$, $L = 1mm$.
   $R_{sh} = 15k - 2$, $f_r = 9GHZ$.
   The tube is oscillating at f_r at the peak of n = $1\frac{3}{4}$ mode.
   Assume β_1
       i. The microwave gap voltage.
       ii. Repeller Voltage for the mode $1\frac{3}{4}$.
   (b) Draw the equivalent circuit of reflex klystron & explain about the electronic admittance of it.   [8+8]

6. (a) A helix travelling wave tube is operated with a Beam current of 300mA, beam Votage of 5KV, characteristic Impedance of 20Ω. What length of helix will be Selected to give an output power gain of 500db at 10GHz.
   (b) Explain the construction & working of TWT.   [8+8]

7. (a) Derive the criterion for classifying the modes of operation for Gunn effect diodes

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$$\boxed{\textbf{Set No. 1}}$$

(b) An n-type GaAs Gunn diode has following parameters

Electron drift velocity $V_d = 2.5 \times 10^5$ m/s

Negative Electron mobility $|\mu_n| = 0.015$ m^2/ v s

Relative dielectric constant $\varepsilon_r = 13.1$

Determine the criterion for classifying the modes of operation. [8+8]

8. (a) How are microwave measurements different from low frequency measurements.

(b) What is the average power of a periodicwave if the peak power is 1300 W and the pulse width is .56 and periodic frequency of the wave is 1500 Hz. [8+8]

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Time: 3 hours   Max Marks: 80

Answer any FIVE Questions
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1. (a) What are TEM, TE, TM and HE modes. Sketch the field patterns for dominant modes in a rectangular wave guides.

   (b) A rectangular wave guide has a = 4 cm, b = 3 cm as its sectional dimensions. Find all the modes which will propagate at 500 MHz.   [8+8]

2. (a) Derive the Q for TM_{111} mode of rectangular cavity assuming lossy conducting walls and lossless dielectric.

   (b) The quality factor of micro strip line is reciprocal of the dielectric loss tangent θ and is relatively constant with frequency. Prove this statement.   [8+8]

3. (a) Show the attenuation produced by rotary vane attenuator is given by - 40 log $(\sin\theta)$.

   (b) Describe in detail about linear phase changer.   [8+8]

4. (a) Describe microwave component which makes use of Faraday rotation principle.

   (b) What are the advantages of scattering matrix representation over impedance or admittance matrix representation?   [8+8]

5. (a) Explain the gain Bandwidth product limitation & Transit angle effects in conventional tubes at microwave frequencies.

   (b) A reflex klystron operates under the following conditions
   $V_0 = 900v, \quad L = 1mm$
   $R_{sh} = 25k - 2, \quad \frac{e}{m} = 1.759 \times 10^{11}, f_r = 9GHZ$
   The tube is oscillating at f_r at the peak of n =2 mode or $1\frac{3}{4}$ mode.
   Assume that the transit time through the gap & beam loading can be neglected.

      i. Find the value of repeller voltage V_r.

      ii. Find the D.C. current necessary to give a microwave gap voltage of 100v.

      iii. What is the electronic efficiency under this condition.   [8+8]

6. (a) The linear magnetron has the following parameters:
   V_o =32KV, I_o = 60A, f=10GHz, B_o= 0.01Wb/m², d=6cm.
   Find

      i. Electron velocity at the hub space.

      ii. Phase velocity for synchronization.

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iii. Hartree anode voltage.

(b) Describe the effect of DC axial field on the electrons traveling from cathode to anode of a magnetron &describe the combined effect of the axial magnetic field & radial DC field .define the cutoff field. [8+8]

7. (a) A Ku-band IMPATT diode has a pulse operating voltage of 100v and a pulse operating current of 0.9 A. The efficiency is about 10%. Calculate

i. The output power

ii. The duty cycle if the pulse width is 0.01ns and frequency is 16 GHz.

(b) Describe the principle of operation of IMPATT diode. [8+8]

8. (a) Describe various techiques of measuring unknown frencuercy of a microwave generator.

(b) A slotted line is used in association with an X-band microwave source, When the line is terminated by a short circuit, adjacent nulls are found at position which are shown as 9.27cm and 11.05 cm. What is the value of the guide wavelength. [8+8]

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Time: 3 hours
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Answer any FIVE Questions
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1. (a) Derive the wave equation for a TM wave and obtain all the field components in a rectangular wave guide.

   (b) A rectangular wave guide with dimension of 3×2 cm operates in the TM_{11} mode at 10 GHz. Determine the characteristic wave impedance. [8+8]

2. (a) What is the impact of skin effect on a micro strip line?

   (b) Derive an expression for attenuation factor for ohmic skin loss. [8+8]

3. (a) Show the attenuation produced by rotary vane attenuator is given by - 40 log (sinθ).

   (b) Describe in detail about linear phase changer. [8+8]

4. (a) Explain the characteristics of ferrite materials.

   (b) Derive the S - matrix for 4 port directional coupler when the coupling factor is 3dB. [8+8]

5. (a) What are the limitations of conventional tubes at microwave frequencies. Describe the construction & working of two cavity klystron amplifier.

   (b) A reflex klystron having an accelerated field of 300v oscillates at a frequency of 10GHZ with a retarding field of 500v. If its cavity is retured to 9GHZ. What must be the new value of retarding field fro oscillations in the same mode to take place? [8+8]

6. (a) In a circular Klystron , a=0.10m, b=0.40m, β= 1.0 mT, Vb=5KV. Find the Hulls Cut-off VOltage & cut-off magnetic flux density.

   (b) Compare & contrast TWT & Klystron amplifier. [8+8]

7. (a) Derive the criterion for classifying the modes of operation for Gunn effect diodes

   (b) An n-type GaAs Gunn diode has following parameters
   Electron drift velocity $V_d = 2.5 \times 10^5$m/s
   Negative Electron mobility $|\mu_n| = 0.015$ m^2/ v s
   Relative dielectric constant $\varepsilon_r = 13.1$

   Determine the criterion for classifying the modes of operation. [8+8]

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8. (a) The cablibrated power from a generator as read at the power meter is 25mw. When a 3dB attenuator with a VSWR of 1.3/1 is inserted between the generator and detector what value should the power meter read.

   (b) Compare the power ratio and RF substitution methods of measuring attenuation provided by the microwave component. [8+8]

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Answer any FIVE Questions
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1. (a) Discuss the attenuation in wave guides in detail.

   (b) A wave guide operating in TE_{10} mode has dimensions a = 2.26 cm and b = 1 cm. The measured guide wave length is 4 cm. Find

      i. Cut off frequency of the propagating mode

      ii. The frequency of operation

      iii. Maximum frequency of propagation in this mode. [8+8]

2. (a) Explain the concepts of propagation delay time for a strip line.

   (b) Is the effective dielectric constant of a micro strip line a function of relative dielectric constant justify. [8+8]

3. (a) Sketch a 4 port hybrid junction and justify that it is a basically a 3 dB directional coupler.

   (b) A matched generator with a power of one watt is connected to the H ? arm of magic tee C (port 4). The E arm (port 3) is match terminated and the length of the coplanar arms is the same. Compute the power delivered to the termination at port 1, 2 and 3 and the power reflected at port 4 when ports 1 and 2 are match terminated. [8+8]

4. What is Faraday rotation? Explain the working of a ferrite circulator with neat sketches. How can it be used as an isolator? [16]

5. (a) Explain in detail bunching process & obtain expression for bunching parameter in a two cavity klystron amplifier.

   (b) A reflex klystron is to be operated at a frequency of 10GHZ. With dc beam voltage 400v. Repeller spacing 0.1cm for $1\frac{3}{4}$ mode. Determine the maximum value of power & corresponding repeller voltage for beam current of 30mA. [8+8]

6. (a) Give the different types & explain the characteristics of slow wave structure.

   (b) A TWT operates with following parameters:
   Vb=2.5KV, Ib=25mA, Z_o=10 Ω, circuit length,L=50,f=9GHz
   Find the gain parameter & power gain. [8+8]

7. (a) Explain the physical structure and construction of IMPATT diodes.

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(b) Draw the graph between negative resistance versus transit angle and explain its Shape.   [8+8]

8. (a) The signal power at the input of a device is 10 mw. The signal power at the output of same device is 0.2mw. Calculate the insertion loss in db of this component.

(b) Explain the bolometric method of measuring microwave power.   [8+8]

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