

**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 TEMn 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  $\lambda_g$  and  $Z_{TE}$  at 10 GHz ( $\lambda_0 = 3$  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:  
 $V_0 = 600v$ ,  $I_0 = 11.45mA$ ,  $L = 1mm$ .  
 $R_{sh} = 15k - 2$ ,  $f_r = 9GHz$ .  
 The tube is oscillating at  $f_r$  at the peak of  $n = 1\frac{3}{4}$  mode.  
 Assume  $\beta_1$ 
  - 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 Voltage of 5KV, characteristic Impedance of  $20\Omega$ . 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

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

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

Negative Electron mobility  $|\mu_n| = 0.015 \text{ m}^2/\text{V s}$

Relative dielectric constant  $\epsilon_r = 13.1$

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 periodic wave 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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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  $\theta$  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  
 $V_0 = 900v$ ,  $L = 1mm$   
 $R_{sh} = 25k - 2$ ,  $\frac{e}{m} = 1.759 \times 10^{11}$ ,  $f_r = 9GHz$   
 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:  
 $V_o = 32KV$ ,  $I_o = 60A$ ,  $f = 10GHz$ ,  $B_o = 0.01Wb/m^2$ ,  $d = 6cm$ .  
 Find  
 i. Electron velocity at the hub space.  
 ii. Phase velocity for synchronization.

- 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
- The output power
  - 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 techniques of measuring unknown frequency 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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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  $3 \times 2$  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  $-40 \log(\sin\theta)$ .  
 (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 retuned to 9GHz. What must be the new value of retarding field for oscillations in the same mode to take place? [8+8]
6. (a) In a circular Klystron ,  $a=0.10m$ ,  $b=0.40m$ ,  $\beta= 1.0$  mT,  $V_b=5KV$ . 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  $\epsilon_r = 13.1$

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

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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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:  
 $V_b=2.5KV$ ,  $I_b=25mA$ ,  $Z_o=10 \Omega$ , 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.

- (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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