EX/PG/ETCE/T/113D/16/2017

M.E.T.C.E Examination, 2017
(1st year,1st Semester)

Microwave and MM Wave Devices and Applications

The figures in margin indicate full marks. All the questions must be answered in one place. The answers should be precise.

Answer any three questions each twenty marks from PART 1 and PART 2. They carry equal marks

PART 1

Use separate answer books for each part

Full Marks:60 for part A

Time: Two hours

Q.1 (a) Give the frequency and wavelength ranges for microwave and mm wave frequencies . 4

(b) Discuss the different band classification for microwave and mm wave frequency ranges. 5

(c) Mention and explain the advantages of microwave over radio waves 5

(d) Why mm wave is important for communication purpose compared to microwaves? 3

(e) List few important semiconducting materials for solid state microwave devices. 3

2(a) What is transferred electron mechanism? Deduce the conditions for observing negative resistance in GaAs. 8

(b) Briefly discuss how the transferred electron mechanism is responsible for microwave oscillations.

Explain the different modes of operation of Gunn Diode. 6

(c) Describe the fabrication and packaging of Gunn diode. Give its typical characteristics and different applications of Gunn diode. 6

Q.3 (a) Explain the one of the waveguide circuits for Gunn diode. 4

(b)Discuss the following

(i) Simplified circuit for a Gunn diode
(ii) Equivalent circuit for a coaxial Gunn Oscillator 10

(c) Explain the following
(i) Why elemental semiconductors are not suitable for fabrication of Gunn diode?
(ii) For a transit time mode, the domain velocity is equal to the carrier velocity of about 10^5 m/sec. Determine the drift length of the diode at a frequency of 10GHz. 6

Q.4 (a) Compare the following IMPATT devices
(i) single drift region
(ii) double drift region
(iii) double avalanche region 6

(b)What are the drawbacks of avalanche devices? Give some specific applications of IMPATT diodes. 4

(c) Compare the performances of Si and GaAs IMPATT diodes. 7

(d) Draw the sketch of power output of different semiconducting material based IMPATT diodes with frequency. 3

Q.5 (a) Describe the following transit time devices
(i)TRAPATT diode

(ii) BARITT diode in terms of operation and performance. Obtain their frequency of operation.
Finally compare them with IMPATT diodes .

12

(b) Discuss the following
(i) Heat sink of mm wave devices,
(ii) Atmospheric window. 8

M. ETCE 1ST SEMESTER EXAMINATION, 2017

MICRO. & MILL. WAVE DEVICES & APPLICATION

Part -2

Answer any **two (2)** from the rest: 2×20=40

1. Derive the expression for junction capacitance of a Varactor diode when it is reverse biased. Give the doping profile, typical structure and equivalent circuit for this diode. Mention the applications of Varactor diode. Explain with suitable circuit diagram how the Varactor diode can be used as a parametric amplifier?

   7+5+3+5

2. Give the cross-sectional view and equivalent circuit of a microwave metal semiconductor field effect transistor (MESFET). A typical n-channel GaAs MESFET has the parameters as $N_d = 8\times10^{17}$ cm^{-3}, $a = 0.1$ μm, $\varepsilon_r = 13.1$, $L = 14$ μm, $Z = 36$ μm, $\mu = 0.08$ m^2/V.s = 800 cm^2/V.s, $V_d = 5$ V, $V_g = -2$ V and $v_s = 2\times10^5$ m/s. Calculate the (i) Pinch-off voltage, (ii) velocity ratio, (iii) saturation current at $V_g = 0$ and (iv) drain current I_d. Derive the necessary formula you use.

   5+3+12

3. What are the limitation of bipolar junction devices used in microwave frequencies? Sketch the cross-sectional view of microwave BJT. Give the microwave equivalent circuits of BJT. How the cut-off frequency of BJT is theoretically estimated? A Si microwave transistor has reactance of 1 ohm, transit time cut-off frequency of 4 GHz, maximum E field 1.6×10^5 V/m and saturation drift velocity of 4×10^5 m/s. Determine the maximum allowable power.

   3+3+4+3+7