SRM Institute of Science and Technology

College of Engineering and Technology

SET-B

DEPARTMENT OF ECE

SRM Nagar, Kattankulathur – 603203, Chengalpattu District, Tamil Nadu

Academic Year: 2022-23 (Even)

Test: CLAT-1
Course Code & Title: 18ECC302J–Microwave and Optical Communication
Year & Sem: III / VI

Date: 17-02-2023
Duration: 12:30 PM–1:30 PM
Max. Marks: 25

	18ECC302J - Microwave & Optical Communications	Program Outcomes (POs)														
		Graduate Attributes												PSO		
S. No.	Course Outcomes (COs)	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	Demonstrate the knowledge on the theory of microwave transmission, microwave generators and associated components.	3	-	-	3	-	-	-	-	-	-	-	-	-	-	1
2	Analyse the microwave passive devices and components.	-	2	-	3	-	-	-	-	-	-	-	-	2	-	-
3	Incorporate microwave measurements and associated techniques with equipment	-	-	3	2	-	-	-	-	-	-	-	-	-	-	3
4	Gain knowledge of the fundamentals on light transmission through fiber	-	3	-	2	-	-	-	-	-	-	-	-	-	-	1
5	Develop a basic optical communication system.	-	3	-	-	3	-	-	-	-	-	-	-	2	-	-
6	Implement the working principle of microwave components, microwave measurements, optical sources, detector and fibers	-	-	3	-	3	-	-	-	-	-	-	-	-	-	3

Part – A

(5 × 3 = 15 Marks)

Instructions: Answer any FIVE Questions.

Q. No.	Question	Marks	BL	CO	PO
1	Why can't conventional tubes be used at microwave frequencies?	3	2	1	1
2	Using Apple gate diagram show how bunching occurs under favourable conditions in a reflex klystron.	3	1	1	1
3	Why magnetron is called cross field device and depict the motion of electrons under the influence of different field conditions.	3	2	1	1
4	How the operation of microwave transistor is different from BJT and also explain its different modes of operation.	3	1	1	1
5	Calculate the oscillation frequency and power output of an IMPATT diode for the following given parameters: L= 5μm, $v_d = 2 \times 10^7$cm/s, V_b= 90 V, V_0 = 100 V, I_0= 300 mA and η= 10%	3	3	1	4
6	A pn junction diode creates a plasma of electrons and holes when reverse biased. Identify the device and explain its various operational regions using a characteristics curve.	3	1	1	1
7	How negative resistance feature of Tunnel Diode is used in oscillators?	3	1	1	1

Evaluation Sheet

Name of the Student:

Register No.:

Part - A (5 × 3 = 15 Marks)					
Q. No.	**CO**	**PO**	**Max. Marks**	**Marks Obtained**	**Total**
1	1	1	3		
2	1	1	3		
3	1	1	3		
4	1	1	3		
5	1	4	3		
6	1	1	3		
7	1	1	3		
Part - B (1 × 10 = 10 Marks)					
8	1	1	10		
9	1	4	10		

Consolidated Marks:

CO	Max. Marks	Marks Obtained
CO1	25	

PO	Max. Marks	Marks Obtained
PO1	28	
PO4	13	
Total	41	

A. Lavanya 15/2/23

Signature of the Course Teacher

16/2/23

Signature of the Course Co-ordinator

(S. SUHASINI)

Signature of the Academic Advisor

SRM
INSTITUTE OF SCIENCE & TECHNOLOGY
(Deemed to be University u/s 3 of UGC Act, 1956)

SRM Institute of Science and Technology
Faculty of Engineering and Technology

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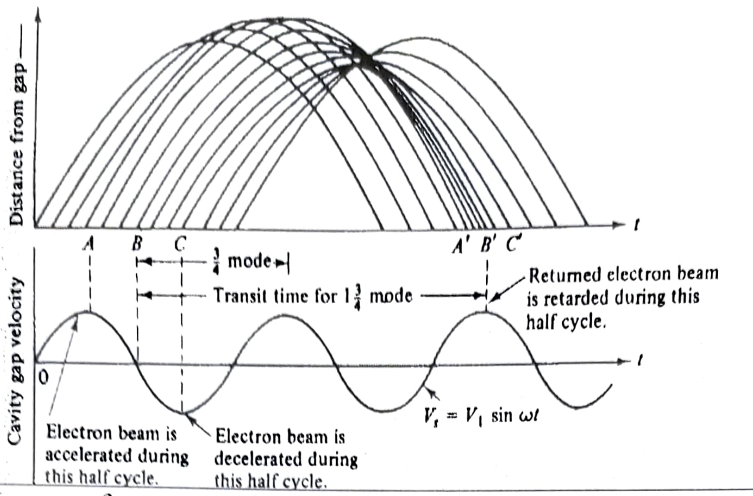
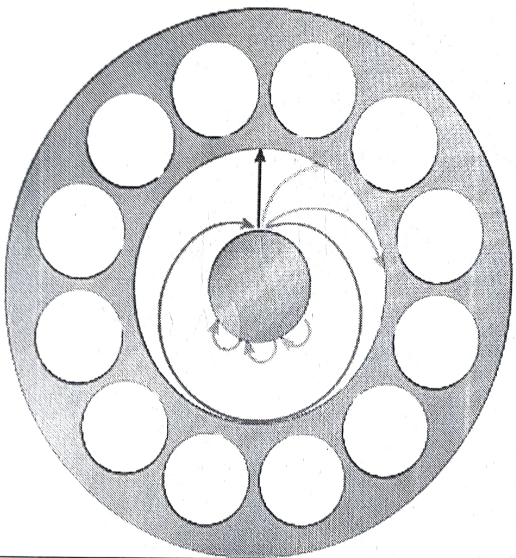
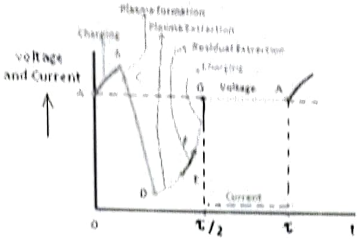
2	Analyse the microwave passive devices and components.	-	2	-	3	-	-	-	-	-	-	-	-	2	-	-
3	Incorporate microwave measurements and associated techniques with equipment	-	-	3	2	-	-	-	-	-	-	-	-	-	-	3
4	Gain knowledge of the fundamentals on light transmission through fiber	-	3	-	2	-	-	-	-	-	-	-	-	-	-	1
5	Develop a basic optical communication system.	-	3	-	-	3	-	-	-	-	-	-	-	2	-	-
6	Implement the working principle of microwave components, microwave measurements, optical sources, detector and fibers	-	-	3	-	3	-	-	-	-	-	-	-	-	-	3

Q. No	Answer with choice variable	Marks	BL	CO	PO
	Part – A **(5 × 3 = 15 Marks)** **Instructions: Answer any FIVE Questions.**				
1	Transit time effect, Lead inductance and Inter electrode capacitance of the devices	3	2	1	1
2	A reference electron passing the gap when the gap voltage is zero travels with no change in velocity. An electron leaving the gap earlier during slightly positive voltage would travel further into repeller space and hence would take longer time then the reference e to return to the gap. An electron leaving the gap later will face slightly negative voltage & gets retarded. So it returns back after a shorter travel in the repeller space. Thus all the electrons would arrive back to the gap in bunches. Bunching around reference electron takes place once per cycle of RF oscillations.	3	1	1	1

					
3	In case of magnetron both the electric field and magnetic field are perpendicular to each other ,hence is called a cross field device 	3	2	1	1
4	In a microwave transistor, initially the emitter-base and collector-base junctions are reverse biased. On the application of a microwave signal, the emitter-base junction becomes forward biased. If a p-n-p transistor is considered, the application of positive peak of signal, forward biases the emitter-base junction, making the holes to drift to the thin negative base. The holes further accelerate to the negative terminal of the bias voltage between the collector and the base terminals. A load connected at the collector, receives a current pulse. Four modes of operation: 1. Normal Mode: In this mode, the emitter base junction of the npn transistor is forward biased and collector base junction is reverse biased. Most transistor amplifiers is operated in normal mode 2. Saturation Mode: When both the emitter base junction and collector base junction are forward biased, the transistor is in saturation mode with low resistance and acts like a short circuit. 3. Cut Off Mode: When both the junctions are reverse biased, the transistor is operated in Cut Off mode. The transistor acts like an open circuit. Both the saturation and cut off modes are used when transistor acts as a switch. 4. Inverted Active Mode: In this mode, the emitter base junction is reverse biased and collector base junction is forward biased	3	1	1	1
5		3	3	1	4

<table>
<tr><td></td><td>(i) The oscillation frequency is
$$f = v_d/(2l) = (2 \times 10^7)/(2 \times 5 \times 10^{-4}) = 20\ \text{GHz}$$
(ii) The power output is
$$P = \eta P_{dc} = \eta V_m I_m = 0.10 \times 100 \times 0.3 = 3\ \text{W}$$</td><td></td><td></td><td></td><td></td></tr>
<tr><td>6</td><td>

AB - Charging – Only charge carrier present and electric field < avalanche break down
BC - Plasma formation- Particle current > external current. Thus electric field decrease but sufficient of avalanche & dense plasma
CD - Plasma formation- Some electron and hole are drift out, field further depressed & traps the remaining plasma
DE - Plasma extraction- Taking time
EF - Residual extraction
FG - Charging</td><td>3</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>7</td><td>Due to heavy doping, the width of the depletion region becomes very thin and an overlap occurs between the conduction-band level on the n-side and the valence-band level on the p-side. Initially under little forward bias condition the conduction-band electrons tunnel through the depletion layer resulting in increase of current with forward voltage. The current reaches maximum of Ip at voltage Vp. For further increase of forward bias, the conduction band electron energy levels are raised above the available energy levels in the valence band and becomes equal to levels in forbidden band. No direct tunnelling occurs and current decreases with increases in forward voltage till Vv showing a negative resistance characteristics for use in amplifiers or oscillators
A regular LC circuit with some voltage applied; it will oscillate normally, but it will suffer from damping - because of Rp -and the oscillation will stop after a while. Now if we add the diode, the negative resistance will cancel Rp and the oscillation will be sustained.</td><td>3</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td></td><td>Part – B
(1 × 10 = 10 Marks)
Instructions: Answer any ONE Question.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>8</td><td>dc beam velocity $u_0 = 0.593 \times 10^6 \sqrt{V_0}$
$= 0.593 \times 10^6 \sqrt{(10 \times 10^3)}$ m/s
$= 0.593 \times 10^8$ m/s (1 mark)
Gap transmit time $t_g = \dfrac{d}{u_0} = \dfrac{2 \times 10^{-3}}{0.593 \times 10^8} = 33.7 \times 10^{-12}$ sec (2 marks)
The gap transit angle $\theta_g = \omega t_g = 2\pi \times 5 \times 10^9 \times 33.7 \times 10^{-12}$ rad
$= 1.059$ rad $= 60.7$ deg (2 marks)
The beam-coupling coefficient
$\beta_1 = \dfrac{\sin(\theta_g/2)}{\theta_g/2} = 0.505/0.5295 = 0.9537$ (1 mark)
The velocity of electrons leaving the input cavity gap
$u(t) = u_0 \left[1 + \dfrac{\beta_1 V_1}{2V_0} \sin(\omega t + \theta_g/2)\right]$
$= 0.593 \times 10^8 [1 + (0.954 \times 100)/(2 \times 10 \times 10^3) \sin(\omega t + \theta_g/2)]$
$= 0.593 \times 10^8 [1 + 0.00477 \sin(\omega t + 0.5295)]$ (3 mark)
is varying sinusoidally at the input cycle
The maximum velocity
$u(t)_{max} = u_0(1 + M/2) = 0.593 \times 10^8 (1 + 0.00477) = 0.5958 \times 10^8$ m/s
The minimum velocity
$u(t)_{min} = u_0(1 - M/2) = 0.593 \times 10^8 (1 - 0.00477) = 0.5902 \times 10^8$ m/s (1 mark)</td><td>10</td><td>3</td><td>1</td><td>1</td></tr>
</table>

9	(a) Angular frequency = $eB_0/m = 1.759 \times 10^{11} \times 0.34$ $= 0.5981 \times 10^{11}$ radian (2 marks) (b) The cut-off voltage = $(eB_0^2 b^2/8m)(1 - a^2/b^2)^2$ $= 1/8 \times 1.759 \times 10^{11} \times 0.34^2 \times (10 \times 10^{-2})^2 \times (1 - 5^2/10^2)^2$ $= 142.97$ kV (4 marks) (c) The cut-off magnetic flux density = $\dfrac{(8V_0 m/e)^{1/2}}{b(1 - a^2/b^2)}$ $= \left(\dfrac{8 \times 25 \times 10^3 \times 1}{1.759 \times 10^{11}}\right)^{1/2} [10 \times 10^{-2}(1 - 5^2/10^2)]^{-1}$ $= 142.2$ mWb/m^2 (4 marks)	10	3	1	4

A. Lavanya 15/2/23

Signature of the Course Teacher

(LAVANYA A.)

16/2/23

Signature of the Course Co-ordinator

(J. SUHASINI)

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SCRUTINY OF QUESTION PAPER

Academic Year: 2022-23 ~~ODD~~/EVEN

Course Code & Title: 18ECC302J–Microwave and Optical Communication

Semester/Year: VI/III

Type of Assessment: CLA T1

Name of the Question paper Setter: Dr. Lavanya A.

Date of Exam: 17.02.2023

Date of Submission to scrutiny member: 15.02.2023

S. No.	Description	Yes/No If no, pl give remarks
1	Correctness of Course code, Title, Date of exam and Duration	
2	Adherence to Question Paper pattern	
3	Uniformity in % of CO coverage	
4	Maintenance of Blooms taxonomy level	
5	Repetition of action verbs	
6	Justification of weightage of marks	
7	Program Criteria(PC) 6 meet	
8	Checking/justifying data in numerical problems	
9	Clarity of images, if any	
10	Grammatical error, Spell check	
11	Uniformity of line space, font size, style	
12	Answer key	
13	Evaluation sheet	
14	Declaration by the Question Paper Setter and the Course Coordinator for Confidentiality	

The question paper is recommended for **Revision/Approved/Approved after revision**

A. Lavanya 15/2/23
Signature of the Question paper Setter

Signature of Scrutiny member