Sri Indu Institute of Engineering & Technology

Recognized Under 2(f) of UGC Act 1956
Approved by AICTE, New Delhi
Affiliated to JNTUH, Hyderabad.

COURSE FILE

ON

Microwave and Optical Communications

Course Code – EC701PC

IV B.Tech ECE I-SEMESTER

A.Y.: 2022-2023

Prepared by

Mr. S. NARESH
Assistant Professor

Head of the Department
Electronics and Communication Engg. Dept
SRI INDU INSTITUTE OF ENGG & TECH
Sheriguda(V), Ibrahimpatnam(M), R.R.Dist-501 510

PRINCIPAL
Sri Indu Institute of Engineering & Tech.
Sheriguda(Vill), Ibrahimpatnam
R.R. Dist. Telangana-501 510.

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Academic Year	2022-2023
Course Title	Microwave and Optical Communications
Course Code	EC701PC
Programme	B.Tech
Year & Semester	IV Year I-Semester
Branch & Section	ECE-C
Regulation	R18
Course Faculty	Mr. S. NARESH, Assistant Professor

Index of Course File

VISION OF THE INSTITUTE

To become a premier institute of academic excellence by providing the world class education that transforms individuals into high intellectuals, by evolving them as empathetic and responsible citizens through continuous improvement.

MISSION OF THE INSTITUTE

IM1: To offer outcome-based education and enhancement of technical and practical skills.
IM2: To Continuous assess of teaching-learning process through institute-industry collaboration.
IM3: To be a centre of excellence for innovative and emerging fields in technology development with state-of-art facilities to faculty and students' fraternity.
IM4: To Create an enterprising environment to ensure culture, ethics and social responsibility among the stakeholders.

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

VISION OF THE DEPARTMENT

To become a recognized center in the field of Electronics and Communication Engineering by producing creative engineers with social responsibility and address ever-changing global challenges.

MISSION OF THE DEPARTMENT

DM1: To facilitate an academic environment that enables student's centric learning.

DM2: To provide state-of-the-art hardware and software technologies to meet industry requirements.

DM3: To continuously update the Academic and Research infrastructure.

DM4: To Conduct Technical Development Programs for overall professional caliber of Stake Holders.

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PROGRAM EDUCATIONAL OBJECTIVES

Program Educational objectives are to Promote:

PEO1: Graduates with a strong foundation in Electronics and Communication Engineering, Science and Technology to become successful in the chosen professional career.

PEO2: Graduates with ability to execute innovative ideas for Research and Development with continuous learning.

PEO3: Graduates inculcated with industry based soft-skills to enable employability.

PEO4: Graduates demonstrate with ability to work in interdisciplinary teams and ethical professional behavior.

PROGRAM SPECIFIC OUTCOMES

PSO 1: Design Skills: Design, analysis and development a economical system in the area of Embedded system & VLSI design.

PSO 2: Software Usage: Ability to investigate and solve the engineering problems using MATLAB, Keil and Xilinx.

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PROGRAM OUTCOMES

1. **ENGINEERING KNOWLEDGE**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **PROBLEM ANALYSIS**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **DESIGN/DEVELOPMENT OF SOLUTIONS**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **CONDUCT INVESTIGATIONS OF COMPLEX PROBLEMS**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **MODERN TOOL USAGE**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

6. **THE ENGINEER AND SOCIETY**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **ENVIRONMENT AND SUSTAINABILITY**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **ETHICS**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **INDIVIDUAL AND TEAM WORK**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **COMMUNICATION**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, give and receive clear instructions.

11. **PROJECT MANAGEMENT AND FINANCE**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **LIFE-LONG LEARNING**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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Website: https://siiet.ac.in/

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B.Tech. in ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE STRUCTURE & SYLLABUS

(Applicable From 2018-19 Admitted Batch)

IV YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	EC701PC	Microwave and Optical Communications	3	0	0	3
2		Professional Elective – III	3	0	0	3
3		Professional Elective – IV	3	0	0	3
4		Open Elective - II	3	0	0	3
5	SM702MS	Professional Practice, Law & Ethics	2	0	0	2
6	EC703PC	Microwave and Optical Communications Lab	0	0	2	1
7	EC704PC	Industrial Oriented Mini Project/ Summer Internship	0	0	0	2
8	EC705PC	Seminar	0	0	2	1
9	EC706PC	Project Stage - I	0	0	6	3
		Total Credits	**14**	**0**	**10**	**21**

Professional Elective – III

EC711PE	Artificial Neural Networks
EC712PE	Scripting Languages
EC713PE	Digital Image Processing

Professional Elective – IV

EC721PE	Biomedical Instrumentation
EC722PE	Database Management Systems
EC723PE	Network Security and Cryptography

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COURSE SYLLABUS

EC701PC: MICROWAVE AND OPTICAL COMMUNICATIONS (PC)

B.Tech. IV Year I Semester

L	T	P	C
3	0	0	3

UNIT - I

Microwave Tubes: Limitations and Losses of conventional Tubes at Microwave Frequencies, Microwave Tubes – O Type and M Type Classifications, O-type Tubes: 2 Cavity Klystrons – Structure,Reentrant Cavities, Velocity Modulation Process and Applegate Diagram, Bunching Process and Small Signal Theory – Expressions for O/P Power and Efficiency. Reflex Klystrons – Structure, Velocity Modulation and Applegate Diagram, Mathematical Theory of Bunching, Power Output, Efficiency, Oscillating Modes and O/P Characteristics.

Helix TWTs: Types and Characteristics of Slow Wave Structures; Structure of TWT and Amplification Process (qualitative treatment), Suppression of Oscillations, Gain Considerations.

UNIT - II

M-Type Tubes:

Introduction, Cross-field Effects, Magnetrons – Different Types, Cylindrical Traveling Wave Magnetron – Hull Cut-off and Hartree Conditions, Modes of Resonance and PI-Mode Operation, Separation of PI-Mode, o/p characteristics,

Microwave Solid State Devices: Introduction, Classification, Applications. TEDs – Introduction, Gunn Diodes – Principle, RWH Theory, Characteristics, Modes of Operation - Gunn Oscillation Modes, Principle of operation of IMPATT and TRAPATT Devices.

UNIT - III

Waveguide Components: Coupling Mechanisms – Probe, Loop, Aperture types. Waveguide Discontinuities – Waveguide Windows, Tuning Screws and Posts, Matched Loads. Waveguide Attenuators – Different Types, Resistive Card and Rotary Vane Attenuators; Waveguide Phase Shifters

– Types, Dielectric and Rotary Vane Phase Shifters, Waveguide Multiport Junctions - E plane and H plane Tees. Ferrites– Composition and Characteristics, Faraday Rotation, Ferrite Components – Gyrator, Isolator,

UNIT - IV

Scattering matrix: Scattering Matrix Properties, Directional Couplers – 2 Hole, Bethe Hole, [S] matrix of Magic Tee and Circulator.

Microwave Measurements: Description of Microwave Bench – Different Blocks and their Features, Errors and Precautions, Measurement of Attenuation, Frequency. Standing Wave Measurements, measurement of Low and High VSWR, Cavity Q, Impedance Measurements.

UNIT - V

Optical Fiber Transmission Media: Optical Fiber types, Light Propagation, Optical fiber Configurations, Optical fiber classifications, Losses in Optical Fiber cables, Light Sources, Optical Sources, Light Detectors, LASERS, WDM Concepts, Optical Fiber System link budget.

TEXT BOOKS:

1. Microwave Devices and Circuits – Samuel Y. Liao, Pearson, 3rd Edition, 2003.
2. Electronic Communications Systems- Wayne Tomasi, Pearson, 5th Edition

REFERENCE BOOKS:

1. Optical Fiber Communication – Gerd Keiser, TMH, 4th Ed., 2008.
2. *Microwave Engineering - David M. Pozar, John Wiley & Sons (Asia) Pvt Ltd., 1989, 3r ed., 2011Reprint.*
3. Microwave Engineering - G.S. Raghuvanshi, Cengage Learning India Pvt. Ltd., 2012. Electronic Communication System – George Kennedy, 6th Ed., McGrawHill.

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Course Outcomes

Course Name: Microwave and Optical Communications

Course Code: EC701PC

Course Year/ Semester: B.Tech IV ECE – C Section

CO Number	Course Outcome (CO)
C411.1	Classify O type and M type microwave tubes
C411.2	Explain the microwave solid state devices and applications
C411.3	Analyze the waveguide components
C411.4	Illustrate microwave measurements by using microwave bench and S matrix determination
C411.5	Explain the basic elements of optical fiber transmission link, types, optical transmitters & receivers
C411.6	Describe the significance of microwave and Optical fibers in Communications

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CO - PO/PSO Mapping & Justification

Course Name: Microwave and Optical Communications **Course Code:** EC701PC

Class: IV B.Tech ECE-C **A.Y.** : 2022-23 **Semester**: I

Course Outcomes:

After completing this course the student will be able to:

C411.1: Classify O type and M type microwave tubes. (Analyze)
C411.2: Explain the microwave solid state devices and applications. (Understand)
C411.3: Analyze the waveguide components (Analyze)
C411.4: Illustrate microwave measurements by using microwave bench and S matrix determination. (Understand)
C411.5: Explain the basic elements of optical fiber transmission link, types, optical transmitters and receivers. (Evaluate)
C411.6: Describe the significance of microwave and Optical fibers in Communications. (Analyze)

Mapping of course outcomes with program outcomes:

High -3 Medium -2 Low-1

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
C411.1	3	3											1	1
C411.2		3		2	1							2	2	2
C411.3				2							3		2	1
C411.4			3									3	1	1
C411.5	2	2			2								2	2
C411.6	3	3		3							3	3	2	1
C411	**2.67**	**2.75**	**3.00**	**2.33**	**1.50**						**3**	**2.67**	**1.67**	**1.33**

CO-PO/PSO Mapping Justification

Course: Microwave And Optical Communications (C411) **Class:** IV ECE - C

PO1.	**ENGINEERING KNOWLEDGE**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2.	**PROBLEM ANALYSIS**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.	**DESIGN/DEVELOPMENT OF SOLUTIONS**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4.	**CONDUCT INVESTIGATIONS OF COMPLEX PROBLEMS**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5.	**MODERN TOOL USAGE**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO11.	**PROJECT MANAGEMENT AND FINANCE**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12.	**LIFE-LONG LEARNING**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1.	**Design Skills:** Design, analysis and development a economical system in the area of Embedded system & VLSI design.
PSO2.	**Software Usage:** Ability to investigate and solve the engineering problems using MATLAB, Keil and Xilinx.

CO-PO Mapping Justification:

C411.1: Classify O type and M type microwave tubes.

	Justification
PO1	Students will be able to study about O type tubes like Klystron Tube, Travelling Wave Tube. Students can able to find solutions for the problems associated with these tubes.
PO2	Students find the problems on rectangular wave guides.
PSO1	Students can improve design and development skills on microwave tubes.
PSO2	Students can investigate and solve problems associated with microwave tubes using software tools.

C411.2: Explain the microwave solid state devices and applications.

	Justification
PO2	Students solve the problems related to M-Type tubes.
PO4	Students get research knowledge on M-Type tubes and Microwave solid state devices.
PO5	Students can select and use appropriate tools to solve the problems related to solid state devices.
PO12	Students recognize the need of microwave tubes, Microwave solid state devices.
PSO1	Students can analysis and design solid state devices.
PSO2	Students can investigate and solve problems associated with microwave solid state devices using different software tools.

C411.3: Analyze the waveguide components

	Justification
PO4	Students Get the research knowledge on different microwave waveguide components which plays a major role to do the research.
PO11	Students can demonstrate knowledge and understand management principles and apply these to analyze waveguide components.
PSO1	Students can analysis, design and develop new waveguide components using different design technologies.
PSO2	Students can investigate and solve problems associated with waveguide components using different software tools.

C411.4 : Illustrate microwave measurements by using microwave bench and S matrix determination.

	Justification
PO3	Students get the solutions for the complex problems related to microwave measurements using S matrix.
PO12	Students can recognize the need of microwave bench and S Matrix.
PSO1	Students can analysis, design and develop new S matrix determination techniques using different design technologies.
PSO2	Students can investigate and solve problems associated with microwave bench and S Matrix using different software tools.

C411.5 : Explain the basic elements of optical fiber transmission link, types, optical transmitters & receivers.

	Justification
PO1	Students Can measure Numerical Aperture , Powers etc. by using some mathematical techniques.
PO2	Students can solve complex problems in the transmission and reception of optical signals.
PO5	Students can understand the utilization of different software's, IT tools in the transmission and reception of optical signals.

PSO1	Students can analysis, design and develop optical transmitters and receivers using different design technologies.
PSO2	Students can investigate and solve problems associated with fiber optic transmitters & receivers using different software tools.

C411.6: Describe the significance of microwave and Optical fibers in Communications.

	Justification
PO1	Students get the knowledge on fiber types, configurations and losses in the optical transmission.
PO2	Students can solve the problems on losses which occur during the transmission and reception of optical signals.
PO4	Students can get research knowledge on different optical sources and optical detectors.
PO11	Students can demonstrate knowledge and understand management principles and apply these in the fields of microwave and optical fibers communication.
PO12	Students can recognize the need of microwave engineering and optical fiber communication.
PSO1	Students can analysis, design and develop new things in the field of microwave engineering and optical fiber communication using different design technologies.
PSO2	Students can investigate and solve problems associated with microwave engineering and optical fiber communication using different software tools.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

ACADEMIC CALENDAR 2022-23

B. Tech./B. Pharm. IV YEAR I & II SEMESTERS

I SEM

S. No	Description	Duration	
		From	To
1	Commencement of I Semester classwork	**29.08.2022**	
2	1st Spell of Instructions (including Dussehra Recess)	29.08.2022	31.10.2022 (9 Weeks)
3	Dussehra Recess	03.10.2022	08.10.2022 (1 Week)
4	First Mid Term Examinations	01.11.2022	07.11.2022 (1 Week)
5	Submission of First Mid Term Exam Marks to the University on or before	12.11.2022	
6	2nd Spell of Instructions	09.11.2022	03.01.2023 (8 Weeks)
7	Second Mid Term Examinations	04.01.2023	10.01.2023 (1 Week)
8	Preparation Holidays and Practical Examinations	11.01.2023	19.01.2023 (1 Week)
9	Submission of Second Mid Term Exam Marks to the University on or before	17.01.2023	
10	End Semester Examinations	*20.01.2023*	02.02.2023(2 Weeks)

Note: No. of Working/instructional days: 94

II SEM

S. No	Description	Duration	
		From	To
1	Commencement of II Semester classwork	**03.02.2023**	
2	1st Spell of Instructions	03.02.2023	31.03.2023 (8 Weeks)
3	First Mid Term Examinations	01.04.2023	08.04.2023 (1 Week)
4	Submission of First Mid Term Exam Marks to the University on or before	15.04.2023	
5	2nd Spell of Instructions	10.04.2023	17.06.2023 (10 Weeks)
6	**Summer Vacation**	15.05.2023	27.05.2023 (2 Weeks)
7	Second Mid Term Examinations	19.06.2023	24.06.2023 (1 Week)
8	Preparation Holidays and Practical Examinations	26.06.2023	01.07.2023 (1 Week)
9	Submission of Second Mid Term Exam Marks to the University on or before	01.07.2023	
10	End Semester Examinations	03.07.2023	15.07.2023 (2 Weeks)

Note: No. of Working/ instructional days: 91

REGISTRAR

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Class Timetable

CLASS: IV-B.Tech ECE-C **A.Y:2022-23** **SEMESTER: I** **LH: B-202**

TIME/ DAY	I 9:40-10:30	II 10:30 -11:20	III 11:20-12:10	IV 12:10-1:00	1:00-1:30	V 1:30-2:20	VI 2:20-3:10	VII 3:10-4:00
MON	DIP	NS&C	MW&OC	JAVA	LUNCH	PPL&E	PPL&E	JAVA
TUE	MW&OC	LIB	NS&C	DIP		INT	CO-CU/DAA	
WED	NS&C	MW&OC	DIP	COUN		JAVA	MW&OC LAB / SEMINAR	
THU	PPL&E	PROJECT STAGE-I				DIP	MW&OC	SPORTS
FRI	JAVA	PROJECT STAGE-I				DIP	NS&C	PPL&E
SAT	NS&C	IOMP				MW&OC	SEMINAR / MW&OC LAB	

*(T) – Tutorial Concern Faculty

Course Code	Course Name	Name of the Faculty
EC701PC	MW&OC-Microwave and Optical Communications	S.Naresh
EC713PE	DIP-Digital Image Processing(Prof.Elec.–III)	Dr.S.Anjaneyulu
EC723PE	NS&C-Network Security and Cryptography (PE – IV)	Dr.T.Ramakrishna
CS703OE	JAVA- Java Programming (Open Elective – II)	Ch.Prabhakar
SM702MS	PPL&E- Professional Practice, Law & Ethics	K.Balakrishna

Course Code	Course Name	Name of the Faculty
EC703PC	MW&OC LAB-Microwave and Optical Communications Lab	Dr.S.Anjaneyulu /S.Naresh
EC704PC	IOMP-Industry Oriented Mini Project	A.Apsara/G.Anitha/P.Meena
EC705PC	Seminar	Dr.T.Ramakrishna/G.Swathi/G.Anusha
EC706PC	Project Stage-I	K.Srikanth/B.Ashwini/T.Divya
LIB	Library	K.Rajender/D.Aruna Kumari
SPORTS	Sports	Y.Rajani
COUN	Counseling	A.Vaani/Dr.S.Anjaneyulu/K.Bhaskar Reddy
INT	Internet	A.Vaani/P.Krishna Rao
CO-CU/ DAA	Co-Curricular/Department Association Activities	Y.Raju/P.Krishna Rao

Class Incharge

Head of the Department
Electronics and Communication Engg. Dept.

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Lesson Plan with Lesson Plan with Number of Hours/Periods, Teaching Aids/Methods, Text/Reference Book

Course Name: Microwave and Optical Communications **Course Code:** EC701PC

Class: B.Tech- IV Year ECE – C **Session Duration:** 50 minutes

Unit-I Syllabus:

Microwave Tubes: Limitations and Losses of conventional Tubes at Microwave Frequencies, Microwave Tubes – O Type and M Type Classifications, O-type Tubes: 2 Cavity Klystrons – Structure, Reentrant Cavities, Velocity Modulation Process and Applegate Diagram, Bunching Process and Small Signal Theory – Expressions for O/P Power and Efficiency. Reflex Klystrons – Structure, Velocity Modulation and Applegate Diagram, Mathematical Theory of Bunching, Power Output, Efficiency, Oscillating Modes and O/P Characteristics.
Helix TWTs: Types and Characteristics of Slow Wave Structures; Structure of TWT and Amplification Process (qualitative treatment), Suppression of Oscillations, Gain Considerations.

No. of Sessions Planned	Topics	Reference	Teaching Method/ Aids
1	Limitations and Losses of conventional Tubes at Microwave Frequencies	T1,R2	BB
2	Classification of Microwave Tubes	T1,R3	BB
	Two cavity klystron Amplifier & It's Mathematical Analysis	T1,R2	PPT
1	Expressions for O/P Power and Efficiency of Two cavity klystron amplifier	T1,R2	BB
1	Reflex Klystron oscillator structure, velocity modulation	T1,R2	BB
1	Reentrant Cavities	T1,R3	BB
2	Reflex Klystron oscillator Applegate Diagram, Mathematical Theory of Bunching	T1,R2	PPT
2	Power Output, Efficiency, Oscillating Modes	T1,R3	BB
1	O/P Characteristics of TWT amplifier	T1,R3	BB
1	Types and Characteristics of Slow Wave Structures	T1,R2	BB
1	Structure of Travelling Wave Tube(TWT) Amplifier	T1,R3	PPT
2	TWT amplification process & Suppression of Oscillations	T1,R2	BB
1	Gain considerations in Helix TWTs	T1,R3	BB

Course Outcome (C411.1): Classify O type and M type microwave tubes

Total Number of Hours/Unit: 16

Unit-II Syllabus:

M-Type Tubes:
Introduction, Cross-field Effects, Magnetrons – Different Types, Cylindrical Traveling Wave Magnetron – Hull Cut-off and Hartree Conditions, Modes of Resonance and PI-Mode Operation, Separation of PI Mode, o/p characteristics,
Microwave Solid State Devices: Introduction, Classification, Applications. TEDs – Introduction, Gunn Diodes – Principle, RWH Theory, Characteristics, Modes of Operation - Gunn Oscillation Modes, Principle of operation of IMPATT and TRAPATT Devices.

No. of Sessions Planned	Topics	Reference	Teaching Method/ Aids
1	Introduction to M-Type tubes and cross field effects	T1,R2	BB
1	Types of Magnetron	T1,R3	BB
2	Cylindrical Traveling Wave Magnetron structure and operation	T1,R3	PPT
1	Hull Cut-off and Hartree Conditions	T1,R2	BB
1	Pi-Mode of Magnetron	T1,R3	BB
1	Magnetron output characteristics	T1,R2	BB
1	Introduction & Classification of microwave solid state devices	T1,R3	BB
1	Introduction to Transferred Electron Devices(TED's)	T1,R2	BB
2	Gunn diode structure, Characteristics of a Gunn diodes	T1,R2	PPT
2	Gunn diode and modes of operation, RWH theory	T1,R2	BB
2	Structure and Principle of operation of IMPATT	T1,R3	BB
1	Structure and Principle of operation of TRAPATT devices	T1,R3	SEMINAR

Course Outcome (C411.2): Explain the microwave solid state devices and applications.

Total Number of Hours/Unit: 16

Unit-III Syllabus:

Waveguide Components: Coupling Mechanisms – Probe, Loop, Aperture types. Waveguide Discontinuities – Waveguide Windows, Tuning Screws and Posts, Matched Loads. Waveguide Attenuators – Different Types, Resistive Card and Rotary Vane Attenuators; Waveguide Phase Shifters – Types, Dielectric and Rotary Vane Phase Shifters, Waveguide Multiport Junctions - E plane and H plane Tees. Ferrites– Composition and Characteristics, Faraday Rotation, Ferrite Components – Gyrator, Isolator.

No. of Sessions Planned	Topics	Reference	Teaching Method/ Aids
2	Waveguide coupling mechanisms	T1,R2	BB
2	Waveguide discontinuities	T1,R3	BB
1	Waveguide Attenuators : Resistive Card	T1,R2	PPT
1	Waveguide Attenuators : Rotary Vane Attenuator	T1,R3	SEMINAR
1	Waveguide Phase Shifters : Dielectric Type Phase Shifter	T1,R3	BB
2	Waveguide Phase Shifters : Rotary Vane Phase Shifter	T1,R2	PPT
1	E-Plane Tee	T1,R3	BB
1	H-Plane Tee	T1,R2	SEMINAR
1	Ferrites composition and characteristics.	T1,R3	BB
1	Faraday Rotation	T1,R2	BB
1	Ferrite Components: Isolator	T1,R3	BB
1	Ferrite Components: Gyrator	T1,R2	BB

Course Outcome (C411.3): Analyze the waveguide components

Total Number of Hours/Unit: 15

Unit-IV Syllabus:

Scattering matrix: Scattering Matrix Properties, Directional Couplers – 2 Hole, Bethe Hole, [S] Matrix of Magic Tee and Circulator.
Microwave Measurements: Description of Microwave Bench – Different Blocks and their Features, Errors and Precautions, Measurement of Attenuation, Frequency. Standing Wave Measurements, measurement of Low and High VSWR, Cavity Q, Impedance Measurements.

No. of Sessions Planned	Topics	Reference	Teaching Method/ Aids
1	Properties of [S] Matrix	T1,R2	BB
1	[S] matrix of E-Plane Tee	T1,R3	BB
1	[S] matrix of H-Plane Tee	T1,R2	BB
1	[S] matrix of Magic Tee	T1,R3	BB
1	[S] matrix of Circulator	T1,R2	BB
1	2 Hole Directional Coupler Structure and [S] matrix	T1,R2	BB
1	Bethe Hole Directional Coupler Structure and [S] matrix	T1,R3	BB
1	Description of Microwave Bench	T1,R2	PPT

1	Different Blocks and their Features of different blocks of microwave bench	T1,R2	PPT
1	Errors and Precautions of different blocks of microwave bench	T1,R3	BB
1	Measurement of Attenuation : Power Ratio Method	T1,R2	BB
1	Measurement of Attenuation : RF Substitution Method	T1,R3	BB
1	Measurement of Frequency : Using Frequency Meter	T1,R3	SEMINAR
1	Measurement of Frequency : Using Slotted Line	T1,R2	BB
1	Measurement of Frequency : Using Down Conversion Method	T1,R2	BB
1	Measurement of Low VSWR and High VSWR	T1,R3	BB
2	Measurement of Impedance	T1,R2	BB
1	Q factor of a cavity	T1,R2	BB

Course Outcome (C411.4): Illustrate microwave measurements by using microwave bench and S matrix determination.

Total Number of Hours/Unit: 19

Unit-V Syllabus:

Optical Fiber Transmission Media: Optical Fiber types, Light Propagation, Optical fiber Configurations, Optical fiber classifications, Losses in Optical Fiber cables, Light Sources, Optical Sources, Light Detectors, LASERS, WDM Concepts, Optical Fiber System link budget.

No. of Sessions Planned	Topics	Reference	Teaching Method/ Aids
2	Introduction to optical fibers & Types of optical fibers	T2,R1	BB
1	Light propagation in optical fibers	T2,R1	PPT
2	Optical fiber configurations	T2,R4	BB
1	Optical fiber classifications	T2,R1	BB
2	Losses in Optical Fiber cables	T2,R4	BB
2	Optical Sources : Structure and Operation	T2,R1	BB
2	Optical Detectors : Structure and Operation	T2,R4	SEMINAR
2	Optical fiber system Link budget	T2,R1	BB
1	Wavelength Division Multiplexing(WDM)	T2,R4	BB

Course Outcome (C411.5): Explain the basic elements of optical fiber transmission link, types, optical transmitters & receivers.

Course Outcome (C411.6): Describe the significance of microwave and Optical fibers in Communications

Total Number of Hours/Unit: 15

TEXT BOOKS:

T1. Microwave Devices and Circuits – Samuel Y. Liao, Pearson, 3rd Edition, 2003.
T2. Electronic Communications Systems- Wayne Tomasi, Pearson, 5th Edition

REFERENCE BOOKS:

R1. Optical Fiber Communication – Gerd Keiser, TMH, 4th Ed., 2008.
R2. Microwave Engineering - David M. Pozar, John Wiley & Sons (Asia) Pvt Ltd., 1989, 3r ed., 2011 Reprint.
R3. Microwave Engineering - G.S. Raghuvanshi, Cengage Learning India Pvt. Ltd., 2012.
R4. Electronic Communication System – George Kennedy, 6th Ed., McGrawHill.

WEB REFERENCES

Course Name: Microwave and Optical Communications **Course Code:** EC701PC

Class: B.Tech- IV ECE – C

1) https://archive.nptel.ac.in/courses/108/103/108103141/
2) https://onlinecourses.nptel.ac.in/noc20_ee91/preview
3) https://archive.nptel.ac.in/courses/108/101/108101112/
4) https://onlinecourses.nptel.ac.in/noc21_ee42/preview
5) https://archive.nptel.ac.in/courses/108/106/108106167/
6) https://archive.nptel.ac.in/courses/117/101/117101002/

SRI INDU INSTITUTE OF ENGINEERING AND TECHNOLOGY

Accredited by NAAC with A+ Grade, Recognized under 2(f) of UGC Act 1956
(Approved by AICTE, New Delhi and Affiliated to JNTUH, Hyderabad)
Khalsa Ibrahimpatnam, Sheriguda (V), Ibrahimpatnam (M), Ranga Reddy Dist., Telangana – 501 510
Website: https://siiet.ac.in/

Lecture Notes

Course Name: Microwave and Optical Communications

Course Code: EC701PC

Course Year/ Semester: B.Tech IV ECE – C Section

S.No	Unit Number	Lecture Notes Link
1	Unit-1	https://drive.google.com/file/d/172RtEDQqz33Zw7X5QJ9uwsagQNGqTmAT/view?usp=drive_link
2	Unit-2	https://drive.google.com/file/d/1jK56aUfk1blsh5x-f_WK1zd6qrFmM7Ux/view?usp=drive_link
3	Unit-3	https://drive.google.com/file/d/1_BOtqYYlC1CFq9jsicdjwNnxyO3AdLw2/view?usp=drive_link
4	Unit-4	https://drive.google.com/file/d/1D3HZotqWrcqnUJOwvVJ0myhHUdU5Hy2e/view?usp=drive_link
5	Unit-5	https://drive.google.com/file/d/1ii-vW8j75DDrisBmX1Pr5bbG8tY1GN4s/view?usp=drive_link

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List of PPTs

Course Name: Microwave and Optical Communications

Course Code: EC701PC

Course Year/ Semester: B.Tech IV ECE – C Section

S.No	Topic Name& PPT Link
1	**Two Cavity Klystron Amplifier:** https://drive.google.com/file/d/1WbyOZVFUZKYpOMukcwZGbMHx5oCh6V6t/view?usp=drive_link
2	**Reflex Klystron Oscillator:** https://drive.google.com/file/d/1LvY35tyvXiAs_ZTDEuZKdZJ94g7HVVK6/view?usp=drive_link
3	**Travelling Wave Tube Amplifier:** https://drive.google.com/file/d/1njiAoCz-9Qt0RnbEtjdDfI1Z1EJzzQjq/view?usp=drive_link
4	**Cylindrical Travelling Wave Magnetron:** https://drive.google.com/file/d/104sxQw5Zlhi8EJLv0qTmII0IogFi3B3s/view?usp=drive_link
5	**Gunn Diode Structure and Characteristics:** https://drive.google.com/file/d/1fOHKmMPYaYvoZV8mFeUfkin5HyRlFufT/view?usp=drive_link
6	**Waveguide Attenuator: Resistive Card:** https://drive.google.com/file/d/1JKw97iAVqXZN6rvbE0H9m5IgflSQ50Wl/view?usp=drive_link
7	**Rotary Vane Phase Shifter:** https://drive.google.com/file/d/1TbfM253L1KHW-Evdg1RdpfYIgd7n9gNd/view?usp=drive_link
8	**Block Diagram of Microwave Bench Setup:** https://drive.google.com/file/d/1D_ixH5MFk9_fn3dEdvOAu43lIh-qYbvw/view?usp=drive_link
9	**Light Propagation in Optical Fibers:** https://drive.google.com/file/d/1rHC-TEKg6pbF5zJvV2muPzlbkYfCvOgl/view?usp=drive_link

Code No: 157CM **R18**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech IV Year I Semester Examinations, February/March - 2022
MICROWAVE AND OPTICAL COMMUNICATIONS
(Electronics and Communication Engineering)

Time: 3 Hours **Max. Marks: 75**

Answer any Five Questions
All Questions Carry Equal Marks
- - -

1.a) Explain in detail the operation of Reflex Klystron and derive equation for its efficiency.
b) What is Velocity modulation? How is it different from normal modulation? Explain how velocity modulation is utilized in Klystron amplifier. [8+7]

2.a) Explain the operation of TWT and derive its gain. Give its characteristics and applications.
b) What is a Gunn Diode? Explain how it works as a Oscillator and also discuss about the characteristic curve. [8+7]

3.a) Explain the operation of magnetron and derive its Hull Cutoff Voltage equation.
b) Explain the operation of IMPATT Diode and explain its characteristics curve. [7+8]

4.a) Discuss the design of Waveguide terminations.
b) With a neat diagram explain in detail about H-plane tee and determine its S-matrix. [8+7]

5.a) What are ferrites? How they are useful in microwaves? Explain faradays rotation.
b) Explain the design and working principle of a Gyrator. [8+7]

6.a) Explain the operation of Magic Tee. Describe how it can be used in constructing a Circulator and a Duplexer.
b) Discuss in detail the operation of a 2-hole directional coupler, Calculate the coupling factor if the power in the primary waveguide is 65mw and the power delivered to the directional coupler is 7mw. [8+7]

7.a) With a neat block diagram of typical microwave bench, explain the functionality of each block.
b) Define an optical fiber. Explain in detail different types of optical fibers with neat sketches. [8+7]

8.a) Explain P-I-N photo detector with neat sketch.
b) Briefly explain the types of losses occur in optical fiber. [7+8]

--ooOoo--

Code No: 157CM **R18**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech IV Year I Semester Examinations, January/February - 2023

MICROWAVE AND OPTICAL COMMUNICATIONS

(Electronics and Communication Engineering)

Time: 3 Hours **Max. Marks: 75**

Note: i) Question paper consists of Part A, Part B.
ii) Part A is compulsory, which carries 25 marks. In Part A, Answer all questions.
iii) In Part B, Answer any one question from each unit. Each question carries 10 marks and may have a, b as sub questions.

PART – A

(25 Marks)

1.a)	What are the limitations of conventional vacuum tubes?	[2]
b)	How the two cavity Klystron acts as an oscillator?	[3]
c)	What is meant by Hull Cutoff Voltage?	[2]
d)	How a Gunn Diode act as an oscillator?	[3]
e)	What is the principle of microwave phase shifter?	[2]
f)	Discuss about waveguide discontinuities?	[3]
g)	Give the properties of S matrix.	[2]
h)	Discuss the significance of slotted section.	[3]
i)	What is a graded index fiber? Sketch its refractive index profile.	[2]
j)	Discuss about "Signal Distortion" in fibres.	[3]

PART – B

(50 Marks)

2.a)	Explain in detail about the classification of M type Microwave tubes.	
b)	Explain the velocity modulation in two cavity Klystron amplifiers.	[5+5]
	OR	
3.a)	Draw the diagram of TWT and explain the operation in detail.	
b)	Explain the significance of Applegate diagram.	[5+5]
4.a)	Explain the growth of oscillations in a travelling wave magnetron.	
b)	Discuss about magnetron and its types.	[5+5]
	OR	
5.a)	Write short notes on "TRAPATT diode".	
b)	What are the different avalanche transit time devices?	[5+5]
6.a)	Discuss in detail about Ferrites Composition and Characteristics.	
b)	Explain about various wave guide attenuators.	[5+5]
	OR	
7.a)	Draw the structure diagram of H-plane Tee and explain its characteristics.	
b)	Explain the principle of Faraday rotation.	[5+5]

8.a) Explain the operation of Directional Coupler with a neat diagram and derive its Scattering Matrix.

b) Describe how a magic tee can be used in constructing a Circulator and a Duplexer.[5+5]

OR

9.a) With the help of a neat sketch, briefly explain the functions of different blocks of a microwave bench.

b) Discuss in detail about measurement of VSWR. [5+5]

10.a) Explain Classification of Optical Fibers.

b) Explain LED Structure with neat sketch. [5+5]

OR

11.a) Describe any two types of Losses in Optical Fiber Communication System.

b) Describe in detail about Rise time Budget of Optical Fibre Communication interms of digital system design. [5+5]

---ooOoo---

Code No: 127FE **R15**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech IV Year I Semester Examinations, November/December - 2018
MICROWAVE ENGINEERING
(Electronics and Communication Engineering)

Time: 3 Hours **Max. Marks: 75**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART- A

(25 Marks)

Why TEM mode is not possible for rectangular waveguides? [2]
b) A rectangular waveguide has the following values l=2.54 cm, b = 1.27 cm waveguide thickness = 0.0127. Calculate the cut-off frequency. [3]
c) What Magic is associated with a Magic Tee? [2]
d) A 20 dB coupler has a directivity of 30 dB. Calculate the value of isolation. [3]
e) What is slow wave structure? [2]
f) How oscillations are prevented in a Travelling Wave Tube? [3]
g) Write down the different types of magnetron. [2]
h) What are the Hull Cut-off and Hartree Conditions? [3]
i) Define scattering matrix. [2]
j) What is a VSWR meter and how will you determine the VSWR? [3]

PART-B

(50 Marks)

2. Explain the wave impedance of a rectangular wave – guide and derive the expression for the wave impedance of TE, TM, and TEM mode? [10]

OR

3.a) A rectangular waveguide has the following dimensions: a=5.1cm, b=2.4cm. i) Calculate the cut-off frequency of the dominant mode. ii) Calculate the lowest frequency and determine the mode closest to the dominant mode.
b) Derive the expression for the characteristic impedance of microstrip lines. [4+6]

Incident power to a directional coupler is 80 watts. The direction coupler has coupling factor of 20 dB, directivity of 30 dB and insertion loss of 0.5 dB. Find the output power at i) main arm, ii) coupled and iii) isolated parts.
b) Explain Faraday rotation with a neat diagram. Explain the working of a ferrite isolator. [4+6]

OR

5.a) Explain the functioning of rotary vane attenuators.
b) A 30 dB directional coupler is used to sample incident and reflected power in a waveguide. The value of VSWR is 2, and the coupler sampling power = 4.5 mW. What is the value of reflected power? [6+4]

6.a) Explain about electronic and mechanical tuning of reflex klystron.

b) A TWT operates under following parameters: Beam Voltage V_o=3KV, Beam current I_o = 20 mA, characteristic Impedance of helix Z_o=10, circuit length, N=50 and frequency f =10 GHz. Determine: i) Gain parameter, ii) Output power gain in dB and iii) all Four propagation constants. [6+4]

OR

7.a) Explain how a helical TWT achieve amplification.

b) An O-type TWT operates at 2GHz. The slow wave structure has a pitch angle of 4.4^0 and attenuation constant of 2 Np/m. Determine the propagation constant of the travelling wave in the tube. [6+4]

8.a) Explain the *pi*-mode operation of magnetron.

b) A magnetron operates with following parameters: V_o = 25KV, I_o=1.25A, B_o= 0.4 wb/m^2, diameter of the cathode = 8cm, Radius of vane edge to center = 8cm. Find the cyclotron frequency and cutoff voltage. [6+4]

OR

9.a) Explain the construction of GUNN diode using RWH theory.

b) Differentiate between TEDs and transistors. [5+5]

10.a) Find the S matrix of isolator.

b) For the given scattering parameters for a two-port network calculate the equivalent impedance parameters if the characteristic impedance is 50Ω.

$S_{11} = 0.4 + j0.7$

$S_{12} = S_{21} = j0.6$

$S_{22} = 0.3 - j0.8$ [5+5]

OR

11.a) Calculate the SWR of a transmission system operating at 8 GHz. Assume TE_{10} wave transmission inside a waveguide of dimensions a =3.5 cm, b=2.1 cm. The distance measured between twice minimum power points (successive minima) is 1 mm on a slotted line.

b) Explain how low power is measured using Bolometer technique. [4+6]

--ooOoo--

Code No: 117FE **R13**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech IV Year I Semester Examinations, November/December - 2016
MICROWAVE ENGINEERING
(Electronics and Communication Engineering)

Time: 3 Hours **Max. Marks: 75**

Note: This question paper contains two parts A and B. Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART- A

(25 Marks)

1.a) Calculate the group and phase velocities for an angle of incidence of 33^0. [2]
b) Explain how the excitation of modes is done in rectangular waveguide? [3]
c) What is Q Factor? [2]
d) Write short notes on Waveguide Irises. [3]
e) What are the limitations of conventional vacuum tubes at microwave frequencies? [2]
f) What is the principle of working of Backward Wave Oscillator? [3]
g) What are the disadvantages of strapping? [2]
h) A magnetron has a cathode radius of 2.5 mm and an anode radius of 5 mm. What is the cut-off potential if a 0.27-Wb/m^2 magnetic field is applied? [3]
i) What is Q of a Cavity Resonator? [2]
j) Why the S-parameters are used in microwaves? [3]

PART-B

(50 Marks)

2.a) Discuss the significance and advantage of dominant mode in rectangular waveguide.
b) A rectangular waveguide with a width of 4 cm and a height of 2 cm is used to propagate an electromagnetic wave in the TE10 mode. Determine the wave impedance, phase velocity, and group velocity of the waveguide for the wavelength of 6 cm. [5+5]

OR

3.a) Distinguish between TE and TM modes of the propagation in rectangular waveguide.
b) A wave of frequency 6GHz is propagated in a parallel plane waveguide separated by 3cm. Calculate i) the cut-off wavelength for the dominant mode. ii) Wavelength in the waveguide. iii) the group and phase velocities. iv) Characteristic wave impedance. [6+4]

4.a) A 20mV signal is fed to the series arm of a lossless Magic Tee junction. Calculate the power delivered through each port when other ports are terminated with a matched load.
b) Explain coupling probes and coupling loops. [4+6]

OR

5.a) Explain the working of a two-hole directional coupler with a neat diagram and derive the expression for the coupling and directivity of a two-hole directional coupler.
b) For a directional coupler, the incident power is 550 mW. Calculate the power in the main and auxiliary arm. The coupling factor is 30 dB. [6+4]

6. Explain in detail bunching process and obtain expression for bunching parameter in a two cavity klystron. [10]

OR

7.a) The parameters of a two-cavity klystron are given by V_b = 900 V, f = 3.2 GHz, and $d = 10^{-3}$ m. Determine electron velocity, transit angle, and beam coupling coefficient.

b) Explain the principle of working of Travelling Wave Tube. [3+7]

8.a) Derive the Hartree anode Voltage equation for linear magnetron.

b) A normal circular magnetron has the following parameters: Inner radius 0.15 m, outer radius 0.45 m, Magnetic flux density 1.6 milli weber/m^2. (i) Determine Hull cut-off voltage (ii) Determine the Hull cut-off magnetic flux density if the beam voltage is 4000 V. [6+4]

OR

9.a) Explain Gunn Effect using two-valley theory? Also explain several modes of operation and applications of Gunn diodes.

b) Give the classification of solid state microwave devices. [6+4]

10.a) Find the S matrix for a matched isolator having an insertion loss of 0.5dB and isolation of 25dB.

b) Explain the S-matrix representation of a multiport microwave network and its significance. [4+6]

OR

11.a) Describe the blocks of microwave bench and their features.

b) Calculate the VSWR of a transmission system operating at 15 GHz.TE_{10} modes is propagating through the waveguide of dimensions 4.0 and 2.1 cm respectively. The distance between two successive minima is 1.5 mm. [7+3]

--ooOoo--

Sri Indu Institute of Engineering and Technology

Sheriguda (Vill), Ibrahimpatnam (Mdl), R.R.Dist-501 510

I- Mid Examinations, Nov -2022

Set – I

Year & Branch: IV ECE-A,B&C Date: 01-11-2022(FN)

Subject: Microwave & Optical Communications Max. Marks: 10 Time: 1 Hour

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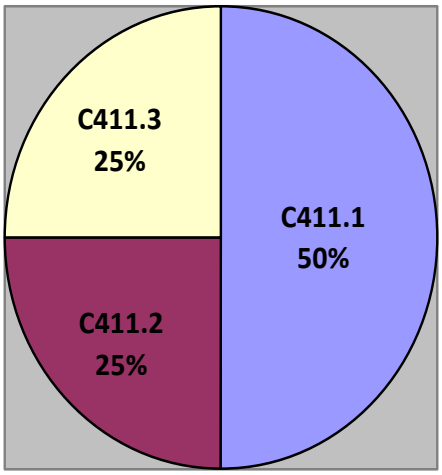
Answer any **TWO** Questions. All Question Carry Equal Marks 2*5=10 marks

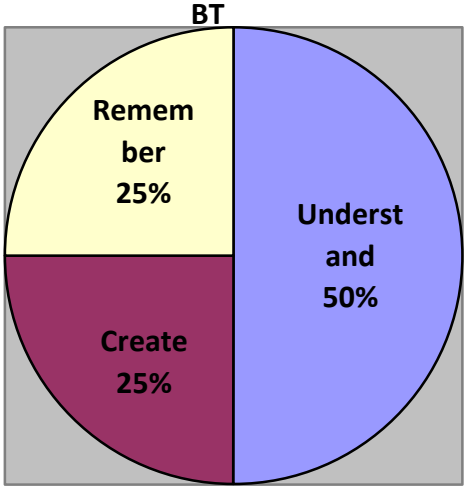
1. Explain the limitations of conventional tubes at microwave frequencies.	(C411.1)	(Understand)
2. Discuss the operation of Two Cavity Klystron amplifier with neat diagram.	(C411.1)	(Create)
3. Write short notes on Gunn Diode.	(C411.2)	(Remember)
4. Explain different waveguide coupling mechanisms with neat diagrams.	(C411.3)	(Understand)

----------All the Best----------

Question Paper Mapping with CO's



Question Paper Mapping with BT



Sri Indu Institute of Engineering and Technology

Sheriguda (Vill), Ibrahimpatnam (Mdl), R.R.Dist-501 510

Microwave and Optical Communications

(Objective Exam)

B.TECH IV YEAR, I SEM, I MID-TERM EXAMS, NOV-2022.

ROLL NO: | **NAME: _____** | **MARKS:**

Date: 01.11.2022 (FN) **Time: 20 Min.** **Max Marks: 10**

Answer All the Questions. All Questions Carry Equal Marks.

I. Choose the Correct Answer:

1. Advantages of Microwaves. [ ]

A) Large Bandwidth B) Large Spectrum Usage

C) Low Power Consumption D) All of the above

2. In a Two cavity Klystron Amplifier space between buncher cavity and catcher cavity is called [ ]

A) Active space B) Transmitting space

C) Drift space D) Reflecting space

3. _____ is not a Microwave Tube from below [ ]

A) Cathode Ray Tube B) Magnetron

C) Travelling Wave Tube D) Reflex Klystron Tube

4. Reflex Klystron works on the principle of _____ [ ]

A) Amplitude Modulation B) Velocity Modulation

C) Phase Modulation D) Space Modulation

5. _____setup is used for measuring any parameter in microwaves. [ ]

A) Microwave Bench B) VSWR

C) Bolometer D) Cavity

6. Efficiency of Two Cavity Klystron Amplifier [ ]

A) 20% B) 45%

C) 58% D) 100%

7. Choose the correct statement from below [ ]

A) TWT contains 2 cavities B) TWT contains 4 cavities

C) TWT contains 3 cavities D) TWT doesn't contain any cavities

8. _____ Structures are used to reduce the velocity of a microwave [ ]

A) Fast Wave Structures B) Slow Wave Structures

C) Beam Structures D) Field Structures

9. Gunn Diode has _____ characteristics [ ]

A) Positive Resistance Characteristics B) Negative Resistance Characteristics

C) Zero Resistance Characteristics D) None

10. 'Ku' band frequency range_____GHZ [ ]

A) 1 to 2 B) 0 to 2 C) 58 to 49 D) 12 to 18

II. Fill in the blanks:

1. Limitations of Conventional Vacuum Tubes are _____
2. Microwave frequency range _____
3. Milli Meter Band(MM Band) frequency range _____
4. Microwave tubes are classified as _____ and _____
5. VSWR stands for _____
6. Efficiency of Reflex Klystron Oscillator_____
7. Name few Slow Wave Structures_____
8. The M- type tubes are also called as_____ tubes
9. List any two operating modes of a Gunn Diode (i) _____

   (ii)_____
10. IMPATT stands for _____

Sri Indu Institute of Engineering and Technology

Sheriguda (Vill), Ibrahimpatnam (Mdl), R.R.Dist-501 510

II- Mid Examinations, JAN -2023

Set – I

Year & Branch: IV ECE-A,B&C — Date: 04 -01-2023(FN)

Subject: Microwave & Optical Communications — Max. Marks: 10 — Time: 1 Hour

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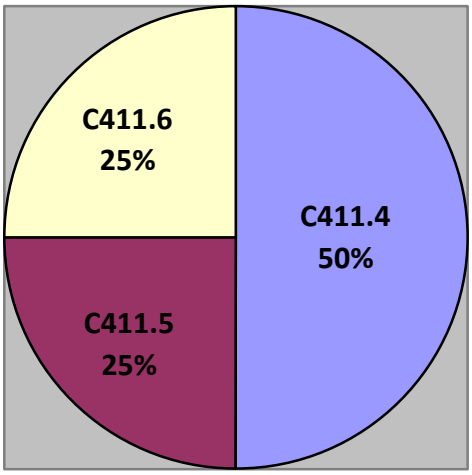
Answer any **TWO** Questions. All Question Carry Equal Marks — 2*5=10 marks

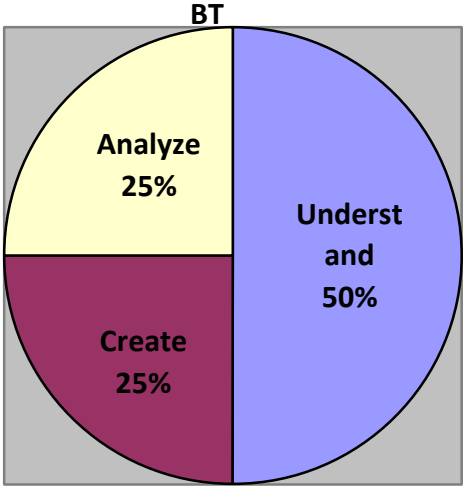
1. Explain the operation of Isolator with neat diagram.	(C411.4)	(Understand)
2. Discuss Microwave Bench in detail.	(C411.4)	(Create)
3. Distinguish different optical fiber configurations.	(C411.6)	(Analyze)
4. Explain WDM in detail.	(C411.5)	(Understand)

----------All the Best----------

Question Paper Mapping with CO's



Question Paper Mapping with BT



Sri Indu Institute of Engineering and Technology

Sheriguda (Vill), Ibrahimpatnam (Mdl), R.R.Dist-501 510

Microwave and Optical Communications

(Objective Exam)

B.TECH IV YEAR, I SEM, II MID-TERM EXAMS, JAN-2023.

ROLL NO: | **NAME:** _____ | **MARKS:**

Date: 04 .01.2023(FN) **Time: 20 Min.** **Max Marks: 10**

Answer All the Questions.

I. Choose the correct alternative: **10*0.5=5 Marks**

1. Series junction is also known as [ ]
   a) E-Plane Tee b) H-Plane Tee
   c) Magic Tee d) None of the above.
2. The tapering at both ends of dielectric slab in phase shifters is used to [ ]
   a) Increase the Reflection b) Reduce the Reflection
   c) Generate the Reflection d) None
3. LED is an [ ]
   a) Optical Source b) Optical Detector
   c) Microwave Source d) None of the above
4. _____ setup is used to measure any parameter in microwaves [ ]
   a) Microwave Bench b) VSWR
   c) E-Plane Tee d) Bolometer
5. H Plane Tee is also called as [ ]
   a) Series junction b) Shunt Junction
   c) EH Tee Junction d) None
6. VSWR is ratio of _____ and _____ [ ]
   a) Maximum Current, Minimum Current b) Maximum Voltage, Minimum Voltage
   c) Maximum Phase, Minimum Phase d) None of the above

7. Optical fibers works on the principle of [ ]

a) Refraction b) Total Internal Reflection

c) Total Numerical Aperture d) None

8. _____ prevents the fiber from any damage. [ ]

a) Core b) Cladding

c) Buffer Coating(Jacket) d) None

9. Fiber Optic Cable operate at frequencies near [ ]

a) 100 GHZ b) 500 MHZ

c) 700 HZ d) 800 THZ

10. A circuit is called Reciprocal if [ ]

a) $S_{ij} = S_{ji}$ b) $S_{ij} > S_{ji}$ c) $S_{ij} < S_{ji}$ d) none

II. Fill in the blanks: **10*0.5=5 Marks**

1. _____ is the example for optical detector.
2. E Plane Tee is called _____ dB Splitter.
3. Advantage of optical fibers _____.
4. Types of Attenuators _____ _____
5. [S] matrix of E-Plane Tee is [S] = _____
6. Attenuation measurement formula _____.
7. Ferrite devices works on the principle of _____
8. LED stands for _____ , LASER stands for _____.
9. Frequency meter in microwave bench is used to measure _____
10. Microwave frequency range _____.

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Website: https://siiet.ac.in/

Internal Question Papers Keys

Course Name: Microwave and Optical Communications

Course Code: EC701PC **A.Y.:** 2022-23 **Semester:** I

Course Year / Semester: B.Tech IV ECE – C Section

S.No	Key Paper Link
1	**Mid-I Descriptive Paper Key Link:** https://drive.google.com/file/d/1aKQijNMdRO2zO3gC3RdE73-7dZ5HnNzU/view?usp=drive_link
2	**Mid-I Objective Paper Key Link:** https://drive.google.com/file/d/1iL_ADOK_Ui3spzfGvfSbtbR7lyHl9eMa/view?usp=drive_link
3	**Mid-II Descriptive Paper Key Link:** https://drive.google.com/file/d/1Hmd_umLYbrg-4wb_Y24be1YNckHF-YGl/view?usp=drive_link
4	**Mid-IIObjective Paper Key Link:** https://drive.google.com/file/d/13JhJQR7EUMM8pqKaMgrS4Dvw7KeJymPR/view?usp=drive_link

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ASSIGNMENT- 1

Course Name: Microwave and Optical Communications **Course Code:** EC701PC

Class: B.Tech- IV Year ECE – C **A.Y.:** 2022-23 **Semester:** I

1) Discuss limitations and losses of conventional tubes at microwave frequencies. (C411.1)(Create)

2) Explain the operation of two cavity klystron amplifier with neat diagram. (C411.1)(Understand)

3) Discuss the operation of cylindrical travelling wave Magnetron. (C411.2)(Create)

4) Explain the operation of Gunn Diode in detail. (C411.2)(Evaluate)

5) Analyze different waveguide coupling mechanisms. (C411.3)(Analyze)

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ASSIGNMENT- 2

Course Name: Microwave and Optical Communications **Course Code:** EC701PC

Class: B.Tech- IV Year ECE – C **A.Y.:** 2022-23 **Semester:** I

1) Explain the operation of Gyrator with neat diagram. (C411.3)(Understand)

2) Derive the S Matrix of E-Plane Tee. (C411.4)(Evaluate)

3) Discuss microwave bench setup in detail. (C411.4)(Create)

4) Explain the light propagation in optical fibers. (C411.5)(Understand)

5) Analyze different optical fiber configurations. (C411.6)(Analyze)

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Website: https://siiet.ac.in/

Assignment Proofs

Course Name: Microwave and Optical Communications

Course Code: EC701PC **A.Y.:**2022-23 **Semester:** I

Course Year / Semester: B.Tech IV ECE – C Section

S. No	Assignment Number	Assignments Proofs Link
1	Assignment-1	https://drive.google.com/file/d/19lEek0I3yemfx44V4UypfHOa_1p8B55t/view?usp=drive_link
2	Assignment-2	https://drive.google.com/file/d/1LXHq6nXCmDqqtWoIpEEJjnAX6jIzo6gr/view?usp=drive_link

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RESULT ANALYSIS TO IDENTIFY SLOW AND ADVANCED LEARNERS

Course Name: Microwave and Optical Communications **Course Code:** EC701PC

Class: B.Tech- IV ECE – C **A.Y.**: 2022-23 **Semester:** I

Slow Learners (From III-II Result Analysis having >=3 backlogs) :

Total 18 slow learners are identified.

Remedial classes are held for improvement of slow learners.

Old and important questions are discussed more.

Home assignments are given regularly.

Counseling is provided regularly.

S.No	Roll Number	No.of Backlogs	MID-I Marks	MID-2 Marks
1	18X31A0403	5S	14	14
2	18X31A0413	5S	15	14
3	18X31A0454	5S	15	14
4	18X31A04D4	5S	15	14
5	18X31A04F1	5S	14	14
6	18X31A04H7	5S	15	14
7	19X31A04B0	3S	22	18
8	19X31A04B5	3S	20	15
9	19X31A04B7	5S	21	14
10	19X31A04C3	4S	22	14
11	19X31A04C7	4S	21	16
12	19X31A04D2	4S	17	15
13	19X31A04D3	5S	18	14
14	19X31A04D8	4S	19	14

15	19X31A04E2	4S	17	18
16	19X31A04E5	5S	14	15
17	20X35A0425	3S	20	22
18	20X35A0426	3S	18	16

Advanced Learners (From III-II Result Analysis having <=2 backlogs):

Total 40 advanced learners are identified.

S.No	Roll Number	Type of Support Provided
1	18X31A04H2	Advanced Concepts material is provided for advanced learners, Subject seminars are presented by advanced learners in the class., Advanced learners are encouraged to support slow learners.
2	19X31A04A1	
3	19X31A04A2	
4	19X31A04A3	
5	19X31A04A4	
6	19X31A04A5	
7	19X31A04A6	
8	19X31A04A7	
9	19X31A04A8	
10	19X31A04A9	
11	19X31A04B1	
12	19X31A04B2	
13	19X31A04B3	
14	19X31A04B4	
15	19X31A04B6	
16	19X31A04B8	
17	19X31A04B9	
18	19X31A04C0	
19	19X31A04C1	
20	19X31A04C2	

21	19X31A04C4	
22	19X31A04C5	
23	19X31A04C6	
24	19X31A04C8	
25	19X31A04C9	
26	19X31A04D0	
27	19X31A04D1	
28	19X31A04D4	
29	19X31A04D5	
30	19X31A04D6	
31	19X31A04D7	
32	19X31A04D9	
33	19X31A04E0	
34	19X31A04E1	
35	19X31A04E3	
36	19X31A04E4	
37	20X35A0421	
38	20X35A0422	
39	20X35A0423	
40	20X35A0424	

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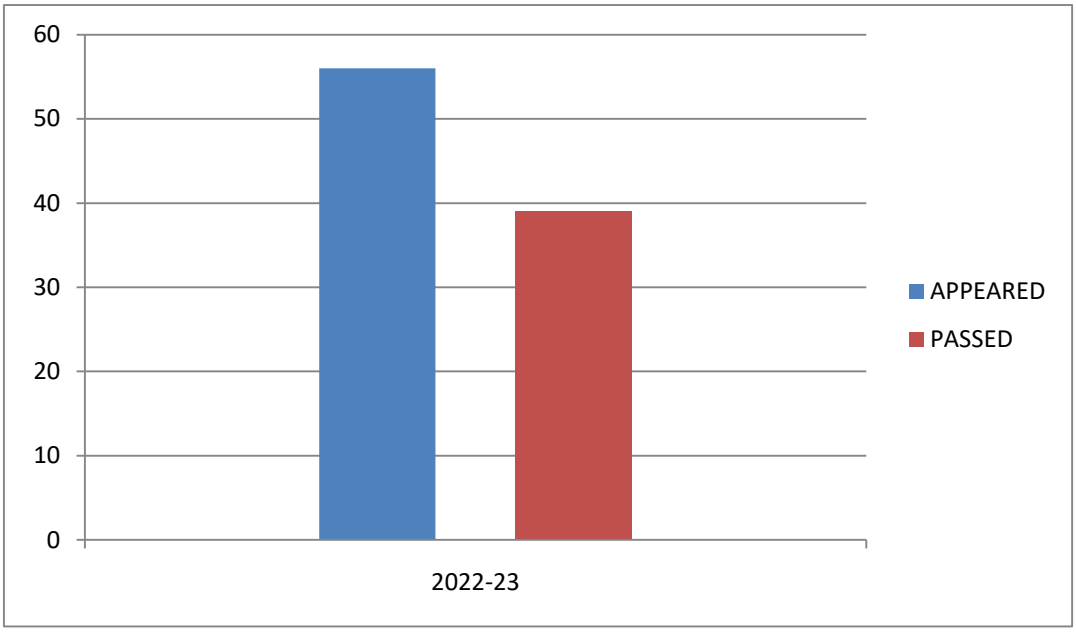
BATCH ECE-IV BTECH I SEM ECE-C RESULT ANALYSIS

ACADAMIC YEAR/ SEMESTER	COURSE NAME	NUMBER OF STUDENTS		QUESTION PAPER SETTING		PASS%
		APPEARED	PASSED	INTERNAL	EXTERNAL	
2022-23 SEMESTER-I	Microwave and Optical Communications	56	39	Course Faculty	JNTU Hyderabad	69.6%

Microwave and Optical Communications Result Analysis



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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

REMEDIAL CLASSES TIME TABLE

A.Y 2022-23 **SEMESTER-I**

BRANCH/ SEC	MON 4.00 PM-5.00 PM	TUE 4.00 PM-5.00 PM	WED 4.00 PM-5.00 PM	THUR 4.00 PM-5.00 PM	FRI 4.00 PM-5.00 PM
II ECE-A	EDC	NATL	DSD	PTSP	SS
II ECE-B	NATL	DSD	PTSP	SS	EDC
III ECE-A	MPMC	DCCN	CS	BEFA	EMI
III ECE-B	DCCN	CS	BEFA	EMI	MPMC
III ECE-C	CS	BEFA	EMI	MPMC	DCCN
IV ECE-A	MW&OC	DIP	PPLE	NS&C	JAVA
IV ECE-B	DIP	PPLE	NS&C	JAVA	MW&OC
IV ECE-C	PPLE	NS&C	JAVA	MW&OC	DIP

HOD Department
Head of the Department
Electronics and Communication Engg. Dept.
SRI INDU INSTITUTE OF ENGG & TECH,
Sheriguda(V), Ibrahimpatnam(M), R.R.Dist-501 510.

PRINCIPAL
PRINCIPAL
Sri Indu Institute of Engineering & Tech.
Sheriguda(Vill), Ibrahimpatnam,
R.R. Dist. Telangana -501 510.

SRI INDU INSTITUTE OF ENGINEERING AND TECHNOLOGY

Department of Electronics and Communication Engineering

Course Outcome Attainment (Internal Examination-1)

Name of the faculty : NARESH SURABU Academic Year: 2022-23

Branch & Section: ECE - C Examination: I Internal

Course Name: MW&OC Year: IV Semester: I

S.No	HT No.	Q1a	Q1b	Q2a	Q2b	Q3a	Q3b	Q4a	Q4b	Obj1	A1
Max. Marks ==>		**5**		**5**		**5**		**5**		**10**	**5**
1	18X31A0403	5								4	5
2	18X31A0413			4						6	5
3	18X31A0454	5								5	5
4	18X31A04D4	3				3				4	5
5	18X31A04F1	2				2				5	5
6	18X31A04H2	4		3						8	5
7	18X31A04H7			2						8	5
8	19X31A04A1	2				2				5	5
9	19X31A04A2			5		5				10	5
10	19X31A04A3	4				4				10	5
11	19X31A04A4	3		2						9	5
12	19X31A04A5	4						3		9	5
13	19X31A04A6	4				4				9	5
14	19X31A04A7			5				4		9	5
15	19X31A04A8			5		5				8	5
16	19X31A04A9	5						4		8	5
17	19X31A04B0			4				5		8	5
18	19X31A04B1	4				4				8	5
19	19X31A04B2	4						3		7	5
20	19X31A04B3			4				4		7	5
21	19X31A04B4	5				4				8	5
22	19X31A04B5			4				3		8	5
23	19X31A04B6	5						4		9	5
24	19X31A04B7			4		4				8	5
25	19X31A04B8	4						4		8	5
26	19X31A04B9			5		4				9	5
27	19X31A04C0	5		5						9	5
28	19X31A04C1			5				5		8	5
29	19X31A04C2	4				4				8	5
30	19X31A04C3			4				4		9	5
31	19X31A04C4	4				4				9	5
32	19X31A04C5	5						5		9	5
33	19X31A04C6			4		5				8	5
34	19X31A04C7	4						4		8	5
35	19X31A04C8			4		4				9	5
36	19X31A04C9	5						5		7	5
37	19X31A04D0			5		4				7	5
38	19X31A04D1	5						5		6	5
39	19X31A04D2			3		3				6	5
40	19X31A04D3	4						3		6	5

41	19X31A04D4			5				5		6	5
42	19X31A04D5	5				4				7	5
43	19X31A04D6			4				4		7	5
44	19X31A04D7	5				5				6	5
45	19X31A04D8			4				4		6	5
46	19X31A04D9	4				4				5	5
47	19X31A04E0			5				4		8	5
48	19X31A04E1	4				4				5	5
49	19X31A04E2			3				2		7	5
50	19X31A04E3	4								6	5
51	19X31A04E4			4				4		6	5
52	19X31A04E5	4								5	5
53	20X35A0421			3				2		8	5
54	20X35A0422	3				3				8	5
55	20X35A0423	4				4				8	5
56	20X35A0424			5				4		8	5
57	20X35A0425	4				3				8	5
58	20X35A0426	3						2		8	5
Target set by the faculty / HoD		3.00	0.00	3.00	0.00	3.00	0.00	3.00	0.00	6.00	3.00
Number of students performed above the target		32	0	25	0	22	0	22	0	50	58
Number of students attempted		34	0	27	0	24	0	25	0	58	58
Percentage of students scored more than target		94%		93%		92%		88%		86%	100%

CO Mapping with Exam Questions:

CO - 1	Y		Y						Y	Y
CO - 2					Y				Y	Y
CO - 3							Y		Y	Y
CO - 4										
CO - 5										
CO - 6										

% Students Scored >Target %	94%		93%		92%		88%		86%	100%

CO Attainment based on Exam Questions:

CO - 1	94%		93%						86%	100%
CO - 2					92%				86%	100%
CO - 3							88%		86%	100%
CO - 4										
CO - 5										
CO - 6										

CO	Subj	obj	Asgn	Overall	Level
CO-1	93%	86%	100%	93%	3.00
CO-2	92%	86%	100%	93%	3.00
CO-3	88%	86%	100%	91%	3.00
CO-4					
CO-5					
CO-6					

Attainment Level	
1	40%
2	50%
3	60%

Attainment (Internal 1 Examination) = **3.00**

SRI INDU INSTITUTE OF ENGINEERING AND TECHNOLOGY

Department of Electronics and Communication Engineering

Course Outcome Attainment (Internal Examination-2)

Name of the faculty : NARESH SURABU Academic Year: 2022-23

Branch & Section: ECE - C Examination: II Internal

Course Name: MW&OC Year: IV Semester: I

S.No	HT No.	Q1a	Q1b	Q2a	Q2b	Q3a	Q3b	Q4a	Q4b	Obj2	A2
Max. Marks ==>		5		5		5		5		10	5
1	18X31A0403	1								8	5
2	18X31A0413			2						7	5
3	18X31A0454	4								5	5
4	18X31A04D4					3				6	5
5	18X31A04F1							1		8	5
6	18X31A04H2							1		8	5
7	18X31A04H7							1		8	5
8	19X31A04A1	4				4				8	5
9	19X31A04A2	5		5						8	5
10	19X31A04A3			4		4				7	5
11	19X31A04A4	3		4						7	5
12	19X31A04A5	4				4				6	5
13	19X31A04A6			5				4		4	5
14	19X31A04A7	5				5				4	5
15	19X31A04A8	5				4				5	5
16	19X31A04A9	5		4						5	5
17	19X31A04B0			3				3		7	5
18	19X31A04B1	4				4				6	5
19	19X31A04B2			4		4				7	5
20	19X31A04B3	4						4		5	5
21	19X31A04B4	5				4				6	5
22	19X31A04B5	3		2						5	5
23	19X31A04B6	4				3				5	5
24	19X31A04B7	4								5	5
25	19X31A04B8			4				4		6	5
26	19X31A04B9	5				5				7	5
27	19X31A04C0			4				4		5	5
28	19X31A04C1			4		4				8	5
29	19X31A04C2	5				4				8	5
30	19X31A04C3			1						8	5
31	19X31A04C4	5						5		7	5
32	19X31A04C5			5		4				9	5
33	19X31A04C6	4						4		9	5
34	19X31A04C7			3		3				5	5
35	19X31A04C8	5						5		5	5
36	19X31A04C9			5		5				4	5
37	19X31A04D0	5				5				5	5
38	19X31A04D1			5				5		4	5
39	19X31A04D2			4						6	5
40	19X31A04D3	4								5	5
41	19X31A04D4			4				3		4	5
42	19X31A04D5	3				3				6	5
43	19X31A04D6			5				4		6	5
44	19X31A04D7	5				5				5	5
45	19X31A04D8			4						5	5
46	19X31A04D9	4				3				6	5

47	19X31A04E0			5				5		6	5
48	19X31A04E1	5				5				7	5
49	19X31A04E2			4				3		6	5
50	19X31A04E3	4								6	5
51	19X31A04E4					5		4		8	5
52	19X31A04E5			4						6	5
53	20X35A0421	1								9	5
54	20X35A0422	4				3				9	5
55	20X35A0423			4						8	5
56	20X35A0424	5						5		8	5
57	20X35A0425	4		4						9	5
58	20X35A0426					4				7	5
Target set by the faculty / HoD		3.00	0.00	3.00	0.00	3.00	0.00	3.00	0.00	6.00	3.00
Number of students performed above the target		29	0	23	0	24	0	15	0	39	58
Number of students attempted		31	0	26	0	24	0	18	0	58	58
Percentage of students scored more than target		94%		88%		100%		83%		67%	100%

CO Mapping with Exam Questions:

CO - 1										
CO - 2										
CO - 3										
CO - 4	Y		Y						Y	Y
CO - 5							Y		Y	Y
CO - 6					Y				Y	Y

CO Attainment based on Exam Questions:

CO - 1										
CO - 2										
CO - 3										
CO - 4	94%		88%						67%	100%
CO - 5									67%	100%
CO - 6					100%				67%	100%

CO	Subj	obj	Asgn	Overall	Level
CO-1					
CO-2					
CO-3					
CO-4	91%	67%	100%	86%	3.00
CO-5		67%	100%	84%	3.00
CO-6	100%	67%	100%	89%	3.00

Attainment Level	
1	40%
2	50%
3	60%

Attainment (Internal Examination-2) = **3.00**

SRI INDU INSTITUTE OF ENGINEERING AND TECHNOLOGY

Department of Electronics and Communication Engineering

Course Outcome Attainment (University Examinations)

Name of the faculty : NARESH SURABU Academic Year: 2022-23

Branch & Section: ECE - C Year / Semester: IV / I

Course Name: MW&OC

S.No	Roll Number	Marks Secured
1	18X31A0403	1
2	18X31A0413	6
3	18X31A0454	
4	18X31A04D4	
5	18X31A04F1	0
6	18X31A04H2	8
7	18X31A04H7	12
8	19X31A04A1	33
9	19X31A04A2	30
10	19X31A04A3	27
11	19X31A04A4	26
12	19X31A04A5	28
13	19X31A04A6	37
14	19X31A04A7	28
15	19X31A04A8	26
16	19X31A04A9	28
17	19X31A04B0	18
18	19X31A04B1	28
19	19X31A04B2	26
20	19X31A04B3	28
21	19X31A04B4	42
22	19X31A04B5	8
23	19X31A04B6	45
24	19X31A04B7	5
25	19X31A04B8	49
26	19X31A04B9	35
27	19X31A04C0	45
28	19X31A04C1	37
29	19X31A04C2	32
30	19X31A04C3	2
31	19X31A04C4	39
32	19X31A04C5	41
33	19X31A04C6	30
34	19X31A04C7	21
35	19X31A04C8	32
Max Marks		75

S.No	Roll Number	Marks Secured
36	19X31A04C9	44
37	19X31A04D0	39
38	19X31A04D1	55
39	19X31A04D2	20
40	19X31A04D3	7
41	19X31A04D4	40
42	19X31A04D5	34
43	19X31A04D6	36
44	19X31A04D7	49
45	19X31A04D8	18
46	19X31A04D9	40
47	19X31A04E0	43
48	19X31A04E1	29
49	19X31A04E2	34
50	19X31A04E3	26
51	19X31A04E4	39
52	19X31A04E5	5
53	20X35A0421	20
54	20X35A0422	29
55	20X35A0423	37
56	20X35A0424	40
57	20X35A0425	15
58	20X35A0426	15

Class Average mark	28
Number of students performed above the target	34
Number of successful students	56

Attainment Level	% students
1	40%
2	50%

Percentage of students scored more than target	61%
Attainment level	**3**

3	60%

SRI INDU INSTITUTE OF ENGINEERING AND TECHNOLOGY

Department of Electronics and Communication Engineering

Course Outcome Attainment

Name of the faculty NARESH SURABU
Academic Year: 2022-23
Branch & Section: ECE - C
Course Name: MW&OC
Year: IV
Semester: I

Course Outcomes	1st Internal Exam	2nd Internal Exam	Internal Exam	University Exam	Attainment Level
CO1	3.00		3.00	3.00	3.00
CO2	3.00		3.00	3.00	3.00
CO3	3.00		3.00	3.00	3.00
CO4		3.00	3.00	3.00	3.00
CO5		3.00	3.00	3.00	3.00
CO6		3.00	3.00	3.00	3.00
Internal & University Attainment:			3.00	3.00	
Weightage			25%	75%	
O Attainment for the course (Internal, Universi			0.75	2.25	
CO Attainment for the course (Direct Method)			3.00		

Overall course attainment level **3.00**

SRI INDU INSTITUTE OF ENGINEERING AND TECHNOLOGY

Department of Electronics and Communication Engineering

Program Outcome Attainment (from Course)

Name of Faculty:	NARESH SURABU	Academic Year:	2022-23
Branch & Section:	ECE - C	Year:	IV
Course Name:	MW&OC	Semester:	I

CO-PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3											1	1
CO2		3		2	1							2	2	2
CO3				2							3		2	1
CO4			3									3	1	1
CO5	2	2			2								2	2
CO6	3	3		3							3	3	2	1
Course	**2.67**	**2.75**	**3.00**	**2.33**	**1.50**						**3.00**	**2.67**	**1.67**	**1.33**

CO	**Course Outcome Attainment**
CO1	3.00
CO2	3.00
CO3	3.00
CO4	3.00
CO5	3.00
CO6	3.00
Overall course attainment level	**3.00**

PO-ATTAINMENT

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO Attainment	**2.67**	**2.75**	**3.00**	**2.33**	**1.50**						**3.00**	**2.67**

CO contribution to PO - 33%, 67%, 100% (Level 1/2/3)

SRI INDU INSTITUTE OF ENGINEERING AND TECHNOLOGY

Accredited by NAAC with A+ Grade, Recognized under 2(f) of UGC Act 1956
(Approved by AICTE, New Delhi and Affiliated to JNTUH, Hyderabad)
Khalsa Ibrahimpatnam, Sheriguda (V), Ibrahimpatnam (M), Ranga Reddy Dist., Telangana – 501 510
Website: https://siiet.ac.in/

Attendance Register

Course Name: Microwave and Optical Communications

Course Code: EC701PC

Course Year/ Semester: B.Tech IV ECE – C Section

S.No	Attendance Register Link:
1	https://drive.google.com/file/d/1Ii4eUU733wZfsZErI7uXiWBzFTnKuW-c/view?usp=drive_link

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Website: https://siiet.ac.in/

Course File Digital Form

Course Name: Microwave and Optical Communications

Course Code: EC701PC

Course Year/ Semester: B.Tech IV ECE – C Section

S.No	Course File Digital Form Link:
1	https://drive.google.com/file/d/1DQexsI9lRpbq_QUgPcIlZXV14Eo4UPoz/view?usp=drive_link