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SAVITRIBAI PHULE PUNE UNIVERSITY

PUNE

FACULTY OF SCIENCE AND TECHNOLOGY

NATIONAL EDUCATION POLICY (NEP) – 2020 COMPLIANT CURRICULUM

DOUBLE MINOR IN

ELECTRONICS & COMMUNICATION SYSTEMS

- ELECTRONICS ENGINEERING
- SATELLITE COMMUNICATION
- TELECOMMUNICATION ENGINEERING
- WIRELESS COMMUNICATION

OFFERED BY
BOARD OF STUDIES "ELECTRONICS & TELECOMMUNICATION"

WITH EFFECT FROM
ACADEMIC YEAR 2026–27

- ELECTRONICS ENGINEERING
- SATELLITE COMMUNICATION
- TELECOMMUNICATION ENGINEERING
- WIRELESS COMMUNICATION

Preface by Board of Studies - Electronics & Telecommunication Engineering

Dear Students and Teachers,

Dear Students and Teachers,

It gives me immense pleasure to present the minor Course in Electronics & Communication Systems for the under-graduate students of Mechanical, Civil, Electrical, Computer, Computer Science, AIDS, AIML, Mechatronics and all those programs (Branch of Engineering) which are not coming under Borad of studies - Electronics & Telecommunication Engineering under the Faculty of Science and Technology of Savitribai Phule Pune University. This course has been designed in alignment with the vision of the National Education Policy (NEP) 2020, emphasizing multidisciplinary learning, innovation, skill development, and industry-oriented education.

In the contemporary digital era, the rapid evolution of technology has seamlessly integrated with Electronics & Communication Systems into every facet of human life, critical infrastructure, and global commerce. While this digital transformation has unlocked unprecedented opportunities for innovation, it has simultaneously exposed organizations and individuals to sophisticated, most closed interface with industry, house hold applications and usable for governance of smart cities

Under the aegis of the Board of Studies (BoS) in Electronics & Telecommunication Engineering, this curriculum for the minor Course in Electronics & Communication Systems which has been meticulously designed for Third Year (TE) and Final Year (BE) engineering students. The primary objective of this specialized program is to bridge the gap between core branch of engineering with Electronics & Communication Engineering and the highly specialized, rapidly evolving domain of information, communication and control.

I sincerely appreciate the valuable contributions of subject experts, academicians, industry professionals, and members of the Board of Studies who have devoted their expertise and efforts in framing this progressive curriculum. I am confident that this minor Course will serve as a strong platform for nurturing future-ready engineers capable of contributing meaningfully to the rapidly evolving Industry revolution.

I extend my best wishes to all students and faculty members for the successful implementation of this Programme.

Dr. S. D. Shirbahadurkar
Chairman,
Board of Studies, Electronics & Telecommunication Engineering
Savitribai Phule Pune University

Members of Board of Studies– E&TC Engineering			
Dr. Aditya Abhyankar	Dr. Rawal Awale	Dr. Sandeep Musale	Dr. Prachi Mukherji
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Program Co-ordinater - Dr.Mrs. Neha Shahare – K J College of Engg Management & Research, Pune			
Support by: Dr.Mrs. Suvarna Chorage Bharati Vidyapeeth College of Engg for women, Katraj, Pune			
Dr. Mrs. Mahua Bhowmik- Dr. D Y Patil Institute of Technology, Pimpri Pune			
Prof. Nabegha Yusufzai- MES Wadia College of Engineering, Pune			

Double Minor in Electronics & Communication Systems

Offered to:

1. Offered to: Instrumentation Engineering	9. Civil Engineering
2. Mechanical and Automobile Engineering	10. Chemical & Petroleum Engineering
3. Mechatronics	11. Biotechnology
4. Petroleum Engineering	12. Robotics and Automation
5. Production and Industrial Engineering	13. Cyber Security
6. Information Technology	14. Artificial Intelligence and Machine Learning
7. Computer Engineering / Computer Science Engg	15. Artificial Intelligence and Data Science
8. Electrical Engineering	16. All programs except programs under BoS -E&TC Engg

Year & Sem	Course Code	Course Name	Teaching Scheme		Examination Scheme					Credits		
			Theory	Practical	CCE	ESE	Term Work	Oral	Total	Theory	Practical	Total
T.E. - V	DMCS301ETC	Electronic Circuits	3	-	30	70	-	-	100	3	-	3
	DMCS302ETC	Electronic Circuits Lab		2			25	25	50		1	1
T.E. -VI	DMCS351 ETC	Analog Communication	3	-	30	70	-	-	100	3	-	3
	DMCS352 ETC	Analog Communication Lab		2	-	-	25	25	50	-	1	1
B.E. - VII	DMCS401 ETC	Digital & Mobile Communication	3		30	70	-		100	3		3
	DMCS402 ETC	Digital & Mobile Communication Lab		2	-	-	25	25	50	-	1	1
B.E -VIII	DMCS 451 ETC	Broad Band Communication	3	-	30	70	-	-	100	3	-	3
	DMCS 452 ETC	Broad Band Communication Lab		2	-	-	25	25	50	-	1	1
	DMCS 452 ETC	Minor Project	-	4			50	50	100		2	2
Total			**12**	**12**	**120**	**280**	**150**	**150**	**700**	**12**	**6**	**18**

Savitribai Phule Pune University Double Minor in Electronics & Communication Systems		
DMCS301ETC : Electronics Circuits		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE:** 30 Marks **End-Semester :** 70 Marks

Course Objectives: The course aims to:

1. To understand the working principles of PN junction diode and Special purpose diodes.
2. To learn the concepts of various logic gates, digital circuits, Microprocessor & Controller.
3. To study the operating principle and applications of MOSFET.
4. To understand the concept of Voltage regulators.
5. To know the methods of measurement of physical parameters using sensors.

Course Outcomes: Upon successful completion of this course, students will be able to:

- CO1: **Know** about the working of different types of diodes.
- CO2: **Learn** logic gates & realization of the digital circuits.
- CO3: **Understand** the working of MOSFET and its characteristics
- CO4: **Analyze** and assess the performance of linear and switching regulators, with their variants, towards applications in regulated power supplies.
- CO5: **Select** sensors based on their working principle for specific applications and its implementation.

Course Contents

Unit I - Diodes and Applications (09Hours)

Evolution of Electronics, Current trends in Electronics. Introduction to active and passive components.
P-N Junction diode construction and V-I characteristics, Diode as a switch. Light Emitting Diode (LED) and photo diode. Zener Diode , LASER Diode Diode (LED) and photo diode along with V- I characteristics and their applications.

Unit II - Logic Gates and Digital Circuits (09 Hours)

Introduction to Number System.
Logic Gates - AND, OR, NOT, XOR, XNOR. Universal Gates – NAND, NOR.
Basic Concept and types of Flip-flops and Counters. Introduction to Microprocessor and Microcontroller (Only block diagram and explanation). Digital IC design flow, IC Fabrication process flow.
Construction, Types, Operation, V-I characteristics, MOSFET as switch & amplifier. Introduction to

Unit III- MOSFET Circuits (09 Hours)

VLSI Technology, Feature size/Channel Length, N Well method of VLSI CMOS manufacturing. MOSFET as switch, CMOS inverter. Nagative Feedback topologies and application. Concept of Oscillators and Types.

Unit IV- Voltage Regulators (09 Hours)

Block diagram of power supply, Fixed and Variable, Block diagram of linear voltage regulator, IC 317 and IC337, Features and specifications, 78XX and 79XX series.

SMPS: Block diagram, Types, features and specifications, typical circuits buck and boost converter.

Unit V- Introduction to Sensors &Transducers (09 Hours)

Classification of sensors: Active /Passive Sensors, Selection Criteria/Characteristics of sensor. Motion Sensors (LVDT), Temperature Sensors (Thermocouple, RTD), Mechanical Sensors (Strain Gauge), Biosensors. Block diagram of IoT based Data Acquisition and Automation System.

Classification of Displacement Sensors: Potentiometer, Strain-gauged element, Capacitive element, Differential transformers, Eddy current proximity sensors, Inductive and Capacitive Proximity switch, Optical encoders. Pneumatic sensors (Bellows, Diaphragm), Hall effect sensors, Accelerometer, Gyroscope and Magnetometer.

Learning Resources

Text Books

1. Donald Neaman, "Electronic Circuits - Analysis and Design", Mc Graw Hill, 3rd Edition.
2. Ramakant Gaikwad, "Op Amps & Linear Integrated Circuits", Pearson Education.
3. Electronics Devices by Thomas.` L. Floyd, 9th Edition, Pearson
4. Modern Digital Electronics by R. P. Jain, 4th Edition, Tata McGraw Hill
5. Sensors and Transducers by D. Patrnabis, 2nd Edition, PHI

Reference Books

1. Millman Halkias, "Electronic Devices & Circuits", 3rd Edition, McGraw Hill.
2. Digital Fundamentals by Thomas. L. Floyd, 11th Edition, Pearson.
3. Sensors Handbook, by S. Soloman, 2nd Edition.
4. CMOS Circuit Design, Layout & Simulation, by Baker, 2nd Edition, Wiley IEEE Press

MOOC / NPTEL/YouTube Links: -

1. NPTEL Course "Analog Electronic Circuits" https://nptel.ac.in/courses/108/105/ 108105158/
2. https://nptel.ac.in/courses/117103063 2.
3. https://nptel.ac.in/courses/117103064 3. 3. https://archive.nptel.ac.in/courses/106/105/106105166/

E-Books :

1. https://www.pearson.com/en-us/subject-catalog/p/electronic-devices-electron- flowversion / P200000001048

Savitribai Phule Pune University Double Minor in Electronics & Communication Systems		
DMCS302ETC :Electronics Circuits Lab		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 02 Hours/Week	01	**TW:** 25 Marks **Oral :** 25 Marks

List of Experiments

[Perform Any Eight Practical]

01	To Study V-I characteristics of P-N Junction Diode.
02	To Study V-I characteristics of Zener Diode.
03	Test and verify the truth tables of: Basic and Universal Gates (Study the datasheet of respective ICs)
04	Build and Test E-MOSFET V-I characteristics.
05	Build and Test CMOS Inverter.
06	Design & implement adjustable voltage regulator using IC LM317/LM337 and comment on Results.
07	Build and test any circuit using BJT/MOSFET/Op-Amp/Logic Gates using any one sensor.
08	Case Study 1 :Any one electronics appliances with block diagram, specification etc.
09	Case Study 2: Design and implement a linear regulator variable power supply.
10	Case Study 3: Design and implement signal conditioning circuit for temperature measurement and control system.

Virtual LAB Links:

1. Basic Electronics Virtual Lab: http://vlabs.iitkgp.ernet.in/be/
2. Electronic Circuits Virtual Lab: https://ec-amrt.vlabs.ac.in/
3. Digital Electronics Circuits Virtual Lab: https://dec-iitkgp.vlabs.ac.in/List%20of%20experiments.html

Note:

1. One practical from each Group should be performed as simulation practical (using any available tool).
2. Additional (min. 2) practical are to be performed using Virtual Lab.

Guidelines for Lab/TW Assessment

- Continuous assessment of laboratory work is to be done based on overall performance.
- Each lab assignment/experiment assessment will assign grade/marks based on parameters with appropriate weightage.
- Suggested parameters for overall assessment as well as each laboratory assignment include: Timely completion, Performance ,Punctuality and neatness.

Savitribai Phule Pune University Double Minor in Electronics & Communication Systems		
DMCS351ETC : Analog Communication		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE:** 30 Marks **End-Semester :** 70 Marks

Course Objectives: The students are expected to demonstrate the ability to:

- Describe and analyze the mathematical techniques of generation, transmission and reception of amplitude modulation (AM), frequency modulation (FM)
- Describe various noise sources
- Convert analog signals to digital format and describe Pulse and digital Modulation techniques.

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: **Understand** and identify the fundamental concepts and various components of analog communication systems.

CO2: **Understand** the basic AM reception process and identify characteristics of radio receivers

CO3: **Understand** and describe FM transmission and reception systems.

CO4: **Define** and Describe sources of noise in communication systems

CO5: **Develop** the ability to compare and contrast the various analog modulation techniques.

Course Contents

Unit I - Fundamentals of Analog Communication and AM Transmission: (09 Hours)

Elements of a communication system, Need and significance of communication systems.
Baseband and carrier communication, Analog and digital communication – basic comparison Applications of communication systems in engineering Concept of modulation and need for modulation Amplitude Modulation Comparison of AM modulation schemes Basic methods of AM generation. Block diagram of AM transmitter Functional description of transmitter.

Unit II - AM Reception and Demodulation (09 Hours)

Basic principles of AM reception, TRF receiver – block diagram and operation, Superheterodyne receiver – block diagram and operation, Advantages of superheterodyne receiver, Receiver Performance Characteristics, Sensitivity, Selectivity, Fidelity, Image frequency, Image Frequency Rejection Ratio (IFRR), Tracking, Mixers – basic principle and applications.

Unit III- FM Transmission and Reception (09 Hours)

Instantaneous frequency, Concept of Angle modulation, frequency spectrum, Narrow band & wide band FM, Modulation index, Bandwidth. Generation of FM (Direct & Indirect Method), Block diagram of transmitter and receiver. Comparison of FM and PM.

Unit IV- Noise (09 Hours)

Sources of Noise, Types of Noise, White Noise, Thermal noise, shot noise, partition noise, Low frequency or flicker noise, burst noise, avalanche noise, Signal to Noise Ratio, SNR of tandem connection, Noise Figure, Noise Temperature, Friss formula for Noise Figure, Noise Bandwidth.

Unit V- Sampling and Pulse Analog Modulation (09 Hours)

Band limited & time limited signals, Narrowband signals and systems, Sampling theorem in time domain, Nyquist criteria, Types of sampling- ideal, natural, flat top, Aliasing & Aperture effect. PAM PWM & PPM. Introduction to Pulse Code Modulation.

Learning Resources

Text Books

1. George Kennedy, "Electronic Communication Systems" 5th Edition, McGraw-Hill.
2. Dennis Roddy &Coolen, "Electronic Communication",4th Edition, Prentice Hall.

Reference Books

1. B. P. Lathi, "Modern Digital and Analog. Communication Systems", 3rd Edition, Oxford University Press.
2. Simon Haykin, "Communication Systems", 4th Edition, John Wiley & Sons.
3. Taub& Schilling, "Principles of Communication Systems", Tata McGraw-Hill.
4. Frenzel, "Principles of Electronic Communication Systems"3rd Edition, Tata McGraw-Hill.

MOOC / NPTEL/YouTube Links: -

1. https://www.vlab.co.in/broad-area-electronics-and-communications
2. https://ae-iitr.vlabs.ac.in/
3. https://iitb.vlabs.co.in/discipline.html?discipline=Electronics_%26_Communications

Savitribai Phule Pune University Double Minor in Electronics & Communication Systems		
DMCS352ETC: Analog Communication Lab		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 02 Hours/Week	01	**TW:** 25 Marks **Oral :** 25 Marks

List of Experiments

[Perform Any Eight Practical]

01	AM Generation Calculation of modulation index by graphical method / Simulate using desirable Software
02	Envelope Detector - Practical diode detector, observe effect of change in RC time constant which leads to diagonal and negative clipping
03	SSB modulator using Filter method/ phase shift method & its detection
04	Frequency modulator & demodulator using IC 565 (PLL based), calculation of modulation index & BW of FM.
05	Study of AM & FM Spectrum: Observe Spectrum of AM & FM on Spectrum Analyzer, Compare & comment on AM & FM spectrum.
06	Measurement of Performance Characteristics of Receiver: Sensitivity, Selectivity, Fidelity
07	Verification of Sampling Theorem, PAM Techniques, (Flat top & Natural sampling), reconstruction of original signal, Observe Aliasing Effect in frequency domain. Following can be performed using suitable software (Any One)
08	Generate AM and FM waveform for given modulation index, signal frequency and carrier Frequency using suitable software.
09	Prove sampling Theorem. Reconstruct the analog signal from its samples. Observe aliasing effect by varying sampling frequency.
10	SNR and PSD of any system (Baseband or AM)

Savitribai Phule Pune University Double Minor in Electronics & Communication Systems		
DMCS 401ETC: Digital & Mobile Communication		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE:** 30 Marks **End-Semester :** 70 Marks

Course Objectives: The students are expected to demonstrate the ability to:

1. To introduce allied branch students to the fundamentals of digital communication
2. To understand basic principles and evolution of mobile communication system
3. To introduce the concept of mobile network and its usage for IoT &Connected devices
4. Explore the application of 5G in real world-use cases**.**

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: **Explain** the core fundamental of digital communication and Mobile Generation Network.

CO2: **Understand** the basic architecture of a mobile network

CO3: **Understand** the roles of SIM/e-SIM, IMSI and IMEI in mobile network identification &device authentication

CO4: **Explain** how IOT and connected devices communicate over mobile network.

Course Contents

Unit I - Introduction to Digital Communication (09 Hours)

Analog vs Digital signals – Basic idea (Continuous vs discrete signals, amplitude, time, examples of analog and digital signals ,What is data: bits, bytes ,bandwidth and basic units (baud rate ,symbol rate), Comparison of ASK,PSK,FSK,QPSK, QAM-in context to the data rate and each modulation technique w.r.t quality of communication, speed ,error detection),Basic concept of bandwidth and speed ,Wired vs Wireless communication, Application in Mobile Communication .

Unit II- Orthogonal Frequency Division Multiplexing (09 Hours)

Introduction, Motivation and Multicarrier basics, OFDM example, bit error rate for OFDM. Multiple-Input Multiple Output Wireless Communications: Introduction to MIMO Wireless Communications, MIMO System Model and MIMO-OFDM.

Unit III - Introduction to Mobile Communication (09 Hours)

Introduction to Cellular Service Progression, Cell Geometry, Overview of Cellular mobile and Network architecture, Cellular radio system design: Frequency assignments, frequency reuse channels, Concept of cell splitting and Cell sectoring. Significance of Handover in cellular systems and roaming.

Unit IV- Mobile Networks (09 Hours)

4G LTE and 5G – basic architecture (basic block diagram), Difference between 4G and 5G (Compare speed, latency and capacity),Mobile Internet and broadband (relate usage), Wi-Fi vs Mobile Network(compare),Hotspot and tethering, Roaming and handover ,Indoor and outdoor coverage (discuss the coverage challenges).

Unit V- Mobile Applications and Emerging Technologies (09 Hours)

Case Studies: Mobile applications and cloud services, Mobile Edge Computing – basic concept, IoT and connected devices, Location-based services and GPS, Video calling and mobile streaming, case studies on Mobile payment and digital banking, AI applications over mobile networks, mobile Connected/autonomous vehicles.

Learning Resources

Text Books

1. Electronic Communication System-Wayne Tomasi-Tata McGraw Hills ,5th Edition.
2. Mobile Cellular Telecommunication: Analog and Digital-William.C.Y.Lee,2nd Edition, Tata McGraw Hills Education.

Reference Books

1. Theodore S. Rappaport, "Wireless Communication, Principles and Practice"-Pearson
2. Jochen Schiller, "Mobile Communication",-Pearson
3. William Stallings "Wireless Communication and Networks-Pearson
4. Cristopher Cox, “An Introduction to LTE: LTE, LTE-Advanced, SAE, VoLTE and 4G Mobile Communications”, Wiley, 2nd Edition.
5. E. Dahlman, J. Skold, and S. Parkvall, “4G, LTE-Advanced Pro and The Road to 5G”, Academic Press, 3rd Edition.

MOOC / NPTEL/YouTube Links: -

1. NPTEL Course “Introduction to Wireless & Cellular Communications” ,
Link of the Course: https://nptel.ac.in/courses/106/106/106106167/.
2. NPTEL Course “Advanced 3G and 4G Wireless Mobile Communications”.
Link of the Course: https://nptel.ac.in/courses/117/104/117104099/.

Savitribai Phule Pune University Double Minor in Electronics & Communication Systems		
DMCS 402ETC: Digital & Mobile Communication Lab		
Teaching Scheme	**Credits**	**Examination Scheme** ,
Theory : 02 Hours/Week	01	**TW:** 25 Marks **Oral :** 25 Marks

List of Experiments	
[Perform Practical Using MATLAB]	
01	Program to implement OFDM and evaluate frame error rate against SNR Indoor MIMO-OFDM Communication Link: https://www.mathworks.com/help/comm/ug/indoor-mimo-ofdm-communication-link-using-ray-tracing.html
02	MIMO Communication System Simulation and Capacity Analysis. a) Simulate 2×2 and 4×4 MIMO systems, evaluate BER, diversity gain, spatial multiplexing gain, and channel capacity improvements.
[Perform any Four Practical Using G-Net Track Lite]	
01	Introduction to GNetTrack and Mobile Network Parameters
02	Signal Strength Mapping Across Campus/Building
03	Comparing Network Types (2G/3G/4G/5G) in Different Areas
04	Observing Handoff/Handover Between Cells
05	Signal Strength vs. Distance from Base Station
06	Indoor vs. Outdoor Signal Quality Comparison
07	Data Throughput/Speed Test Correlation with Signal Strength
08	Case Study – Relating GNet Track Data to a Branch-Specific Application

Savitribai Phule Pune University Double Minor in Electronics & Communication Systems		
DMCS 451 ETC: Broad Band Communication		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE:** 30 Marks **End-Semester :** 70 Marks

Course Objectives: The students are expected to demonstrate the ability to:

1. To Understand the basic concept of broadband communication.
2. To Identify different broadband access technologies.
3. To Understand basic optical fibre and FTTH systems.
4. To provide knowledge of Wi-Fi, 4G/5G and OFDM concepts at a basic level.
5. To Understand basic networking, QoS and broadband applications.

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: **Explain** the basic concepts, architecture and terminology of broadband communication systems.
CO2: **Identify** and compare different broadband access technologies such as DSL, cable, wireless and optical-based access.
CO3: **Explain** the basic principles of optical fibre communication and FTTH systems.
CO4: **Descri**be the basic working of Wi-Fi, 4G/5G, OFDM and related wireless broadband technologies.
CO5: **Explain** the fundamentals of broadband networking, Quality of Service (QoS) and broadband applications.

Course Contents

Unit I - Basics of Broadband Communication (09 Hours)

Introduction to Communication: Bandwidth and data rate ,Wired and wireless, Broadband vs narrowband ,Types of broadband: DSL, Fiber, Cable, Mobile broadband, Network Components: Modem, Router, Switch, ISP, Internet, Broadband Performance: Throughput, latency, Jitter. and packet Loss.

Unit II - Introduction to Optical Fibre and FTTH (09 Hours)

Optical Fiber :Need for optical communication ,Principle of total internal reflection, Core, cladding and coating, Single-mode and multimode fibre – basic comparison, selection of optical sources and photodetectors, types of optical fibres (brief introduction).

Unit III - Wireless Broadband (09 Hours)

Wireless Broadband: Wi-Fi – basic working ,Bluetooth – basic comparison ,Bluetooth – basic ,WiMAX introduction , Simple comparison of 3G, 4G and 5G, , its application in Wi-Fi and 5G, Basic SNR/SINR.

Unit IV- Broadband Networking and Multimedia Application (09 Hours)

Basic Networking Concepts: LAN, MAN and WAN,Internet architecture, IP address,MAC address, Basic Protocols: IP ,TCP, UDP, HTTP/HTTPS (Only basics) , Multimedia Applications: Voice over IP,Video calling, Video streaming ,Online gaming ,Online classes

Unit IV- Broadband Applications and Emerging Technologies **(09 Hours)**

Broadband Applications: Smart home, Online banking, Telemedicine, Smart city, Cloud and Edge Computing: Basic of cloud computing, its application, Cloud vs Edge – basic comparison , Introduction to SDN,
Case Studies on Other Communication Technologies: Satellite Communication and Drone Technology.

Learning Resources

Text Books

1. Data Communications and Networking — Behrouz A. Forouzan, *Data Communications and Networking*, McGraw Hill Education, 5th Edition.
2. High-Speed Networks and Internets — William Stallings, *High-Speed Networks and Internets: Performance and Quality of Service*, Pearson Education, 2nd Edition.
3. Optical Fiber Communications — Gerd Keiser, *Optical Fiber Communications*, McGraw Hill Education, 5th Edition.
4. Broadband Networking — Uyless Black, *Broadband Networking: ATM, SDH and SONET*, Prentice Hall, 2nd Edition.

Reference Books

1. Optical Networks — Rajiv Ramaswami and Kumar N. Sivarajan, Optical Networks: A Practical Perspective, Morgan Kaufmann Publishers, 3rd Edition.
2. Wireless Communications — Theodore S. Rappaport, Wireless Communications: Principles and Practice, Pearson Education, 2nd Edition.
3. Computer Networks — Andrew S. Tanenbaum and David J. Wetherall, Computer Networks, Pearson Education, 5th Edition.
4. Fiber-Optic Communication Systems — Govind P. Agrawal, Fiber-Optic Communication Systems, Wiley India, 4th Edition.

Savitribai Phule Pune University Double Minor in Electronics & Communication Systems		
DMCS 452 ETC: Broad Band Communication Lab		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 02 Hours/Week	01	**TW:** 25 Marks **Oral :** 25 Marks

List of Experiments	
Group A: Fundamental Experiments (Any 3) [Use any Software]	
1	Study of broadband communication architecture and ISP network. (LAN, MAN, WAN, ISP backbone modeling)
2	Study of GPON/EPON architecture and FTTH network components.
3	Study of Broadband Service Delivery -DSL, cable modem, fiber access concepts
4	Analysis and demonstration of WDM-based optical communication system.
5	Simulate 3G, 4G LTE, and 5G scenarios, then evaluate speed, latency, bandwidth efficiency, and user capacity.
6	Configure a Wi-Fi network and test connectivity between connected devices .
Group B: Intermediate Level Broadband Experiments (Any 3) [Use any Software]	
1	Design and analysis of FTTH fiber network planning.
2	Measurement of attenuation and dispersion in optical fiber.
3	Traffic monitoring and packet analysis (VoIP, IPTV, traffic prioritization) using Wireshark
4	VLAN and Inter-VLAN Routing
5	IoT Smart Home over Broadband
6	IP Addressing and Sub netting.
Software Required	
Cisco Packet Tracer	Routing, switching, ISP basics
GNU Radio	RF and wireless experiments
MATLAB	Signal processing and communication simulation
Wireshark	Packet analysis

NPTEL Courses: **1.** https://nptel.ac.in/courses/106105183

2. https://nptel.ac.in/courses/106105160

Virtual Labs:

1. **https://www.netacad.com/cisco-packet-tracer**
2. **https://in.mathworks.com/products/communications.html**
3. **https://www.netacad.com/cisco-packet-tracer**
4. **https://www.nsnam.org/**

Savitribai Phule Pune University Double Minor in Electronics & Communication Systems		
DMCS 453 ETC: Minor Project		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 04 Hours/Week	02	**Term Work:** 50 Marks **Oral** : 50 Marks

The Minor Project is an integral component of the Double Minor in Electronics & Communication Systems and is intended to provide students with practical exposure to Electronics and communication through the applications of electronics and communication programming, database, web/mobile development, Electronic software tools, microcontroller and embedded and related technologies.

Course Objectives: After completion of the course, students will have adequate background, conceptual clarity and knowledge related to:

- Develop problem solving ability using core Electronic concepts.
- Understand basics of Communication.
- Develop critical thinking for solving problems using core knowledge of Electronics Engineering.
- Work in TEAM and learn professionalism.

Course Outcomes: After learning the course, the students will be able to:

1. Develop projects applying Electronic Circuits concepts.
2. Practice acquired knowledge within the chosen area of technology for project development.
3. Organize and Maintain large collection of related data.
4. Organize information in digital space.

Nature of the Minor Project

1. The Minor Project shall preferably be application-oriented and multidisciplinary. Students are encouraged to identify problems from engineering, management, education, healthcare, agriculture, finance, social services, sustainability and other relevant domains.

2. The project should result in a working software application/prototype with Hardware rather than being limited to a literature survey or theoretical study.

3. Group Size: 2 to 3 students per group. Individual projects may be permitted under special depart -- mental approval. Although the project may be undertaken in a team, individual contribution must be clearly identifiable.

4. Cross-Disciplinary Projects:

- IOT Based Automation, healthcare and agriculture Designs.
- Embedded Based Design for healthcare and automation.
- SCADA/PLC interfaces and industrial telemetry dashboards.
- Biomedical signal processing utilities or embedded firmware interfaces.

5. The project should include appropriate engineering analysis, testing, validation, and performance evaluation.
6. Students should maintain a **project diary** documenting weekly progress, discussions, implementation activities, and observations.
7. The final report should include:

- Objectives
- Literature review
- Methodology
- Design and implementation
- Results and discussion
- Conclusions
- Future scope
- References

8. Wherever applicable, students should consider:

- Electrical safety standards
- Energy efficiency
- Sustainability
- Reliability
- Cost effectiveness

Suggested Project Themes for Students

1. Mobile Applications
2. Robotics
3. Industrial Automation
4. Predictive Maintenance
5. Autonomous Vehicles
6. Smart Manufacturing
7. Structural Health Monitoring
8. Intelligent Transportation
9. Smart Parking
10. Disaster-Warning Systems
11. IOT and Edge Computing
12. Smart Surveillance
13. Wireless Sensor Networks
14. Embedded Machine Learning
15. EV Battery Management
16. Smart Grid
17. Renewable-Energy Monitoring
18. Power-Quality Monitoring
19. Smart Energy Meters
20. Industrial Pollution Monitoring