

NORTH LAKHIMPUR UNIVERSITY



(As recommended by Board of Studies in Electronics held on 20.06.2026 and Approved by Academic Council held on 25.06.2026)

Curriculum for FYUGP in **ELECTRONICS As per NEP-2020**

(All Semester)

UG Course Structure as per NEP 2020 Guidelines
Department of Electronics

SEMESTER-I

Course	Course Title	Course Code	Credit	Marks	End Sem	IA
DSC/ Major -101	Basic Circuit Theory and Network Analysis	MAJ-5-ELE-101	4+1	100	56	24
					20	
DSE/Minor-101	Basic Circuit Theory and Network Analysis	MIN-5-ELE-101	4+1	100	56	24
					20	
MDC-101	Introduction to Electronics	MD-3-ELE-101	2+1	60	28	12
					20	
SEC-101	Fundamentals of Electricity and Domestic Wiring	SEC-3-ELE-101	1+2	80	28	12
					40	
Total			16	340	268	72

SEMESTER-II

Course	Course Title	Course Code	Credit	Marks	End Sem	IA
DSC/ Major -201	Semiconductor Devices	MAJ-4-ELE-201	4+1	100	56	24
					20	
DSE/Minor-201	Semiconductor Devices	MIN-4-ELE-201	4+1	100	56	24
					20	
MDC-201	Number System and Logic Circuits	MD-3-ELE-201	2+1	60	28	12
					20	
SEC-201	Solar Installation and Maintenance	SEC-3-ELE-201	1+2	80	28	12
					40	
Total			16	340	268	72

SEMESTER-III

Course	Course Title	Course Code	Credit	Marks	End Sem	IA
Major -301	Analog Electronics	MAJ-4-ELE-301	3+1	80	42 20	18
Major -302	Digital Electronics	MAJ-4-ELE-302	3+1	80	42 20	18
DSE-301(A) OR DSE-301(B) (for Major discipline)	Mathematical Foundation for Electronics OR Introduction to Web Design	DSE-2-ELE-301(A) OR DSE-2-ELE-301(B)	2	40	28	12
MIN-301	Digital Electronics	MIN-2-ELE-301	2	40	28	12
MDC-301	Fundamentals of Electronic Measurements	MDC-3-ELE-301	3	60	42	18
SEC-301	(A) Programming in C OR (B) Electrical and Solar Power: Field Practices	SEC-3-ELE-301	1+2*	80	28 40	12
Total			18	380	290	90
*Field Visit						

SEMESTER-IV

Course	Course Title	Course Code	Credit	Marks	End Sem	IA
MAJ-401	Operational Amplifiers and Applications	MAJ-4-ELE-401	4	80	56	24
MAJ-402	Signals and Systems	MAJ-4-ELE-402	3+1	80	42 20	18
MAJ-403	Electronic Instrumentation	MAJ-4-ELE-403	3+1	80	42 20	18
DSE-401	(A) Electronic Materials OR (B) Internet of Things (IoT)	DSE-4-ELE-401A OR DSE-4-ELE-401B	4	80	56	24
Total			16	320	236	84

SEMESTER-V

Course	Course Title	Course Code	Credit	Marks	End Sem	IA
MAJ-501	Microprocessor and Microcontroller	MAJ-4-ELE-501	4+1	100	56	24
					20	
MAJ-502	Programming in C and C++	MAJ-4-ELE-502	3+1	80	42	18
					20	
MAJ-503	Power Electronics	MAJ-4-ELE-503	3+1	80	42	18
					20	
DSE-501	Photonics	DSE-3-ELE-501(A)	3	60	42	18
	OR Biomedical Instrumentation	DSE-3-ELE-501(B)				
Total			16	320	242	78

SEMESTER-VI

Course	Course Title	Course Code	Credit	Marks	End Sem	IA
MAJ-601	Electronics Lab	MAJ-P5-ELE-601	5	100	70	30
MAJ-602	Introduction to VLSI circuits	MAJ-4-ELE-602	4	80	56	24
MAJ-603	Electrical Machines	MAJ-4-ELE-603	4	80	56	24
MAJ-604	Sensors, Transducers and Actuators	MAJ-4-ELE-604	4	80	56	24
DSE-601	(A) Optoelectronics OR (B) Robotics	DSE-3-ELE-601	3	60	42	18
Total			20	400	280	120

SEMESTER-VII

Course	Course Title	Course Code	Credit	Marks	End Sem	IA
MAJ-701	Microwave and Electromagnetics	MAJ-4-ELE-701	4	80	56	24
MAJ-702	Analog and Digital Communication	MAJ-4-ELE-702	3+1	80	42	18
					20	
MAJ-703	Advanced Semiconductor Devices	MAJ-4-ELE-703	3+1	80	42	18
					20	
DSE-701	(A) Machine Learning OR (B) Introduction to IC Design OR (C) Mobile Communication	DSE-4-ELE-701(A) OR DSE-4-ELE-701(B) OR DSE-4-ELE-701(C)	4	80	56	24
MIN-701	Operational Amplifiers and Applications	MIN-4-ELE-701	3+1	80	42	18
					20	
Total			20	400	292	108

SEMESTER-VIII

Course	Course Title	Course Code	Credit	Marks	End Sem Marks	Internal Assessment
MAJ-801	Indian Scientific Traditions and Electronics	MAJ-4-ELE-801	4	80	56	24
MAJ-802	Research Methodology	RM-4-ELE-802	4	80	56	24
*For award of B.Sc. Honours						
*MAJ-803	Introduction to CMOS Circuits	MAJ-4-ELE-803	4	80	56	24
*MAJ-804	Control Systems	MAJ-4-ELE-804	4	80	56	24
*MAJ-805	Project Work	MAJ-4-ELE-805	4	80	56	24
**Students eligible and opting for B.Sc. Honours with Research must complete a research project of 12 credits in lieu of *MAJ-803, *MAJ-804, and *MAJ-805						
**MAJ-803	Dissertation	MAJ-4-ELE-803	12	240	168	72
Total			20	400	280	120

SEMESTER-I

Course Title : BASIC CIRCUIT THEORY AND NETWORK ANALYSIS
Course Code : MAJ-5-ELE-101
Nature of the Course : CORE/MAJOR
Total Credit assigned : 5
Components of the course : L-4, P-1, T-0
Distribution of Marks : End Semester: 56 In Semester: 24 Practical:20

Course Contents

Unit	Contents	M	L	P	T
I	Basic Circuit Concepts: Voltage and Current Sources, Resistors: Fixed and Variable resistors, Construction and Characteristics, Color coding of resistors, resistors in series and parallel. Inductors: Fixed and Variable inductors, Self and mutual inductance, Faraday's law and Lenz's law of electromagnetic induction, Energy stored in an inductor, Inductance in series and parallel Capacitors: Principles of capacitance, Parallel plate capacitor, Permittivity, Definition of Dielectric Constant, Dielectric strength, Energy stored in a capacitor, Air, Paper, Mica, Teflon, Ceramic, Plastic and Electrolytic capacitor, Construction and application, capacitors in series and parallel, factors governing the value of capacitors	12	13		2
II	Circuit Analysis: Kirchhoff's Current Law (KCL), Kirchhoff's Voltage Law (KVL), Node Analysis, Mesh Analysis, Star-Delta Conversion. DC Transient Analysis: RC Circuit- Charging and discharging with initial charge, RL Circuit with Initial Current, Time Constant, RL and RC Circuits with Sources, DC Response of Series RLC Circuits	12	13		1
III	AC Circuit Analysis: Sinusoidal Voltage and Current, Definition of Instantaneous, Peak, Peak to Peak, Root Mean Square and Average Values. Voltage-Current relationship in Resistor, Inductor and Capacitor, Phasor, Complex Impedance, Power in AC Circuits: Instantaneous Power, Average Power, Reactive Power, Power Factor. Sinusoidal Circuit Analysis for RL, RC and RLC Circuits. Resonance in Series and Parallel RLC Circuits, Frequency Response of Series and Parallel RLC Circuits, Quality (Q) Factor and Bandwidth. Passive Filters: Low Pass, High Pass, Band Pass and Band Stop	17	18		1
IV	Network Theorems: Principal of Duality, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, Millman's Theorem, Maximum Power Transfer Theorem. AC circuit	15	16		1

	analysis using Network theorems. Two Port Networks: Impedance (Z) Parameters, Admittance (Y) Parameters, Transmission (ABCD) Parameters.				
V	PRACTICAL 1. Familiarization with a. Resistance: Types and color codes b. Bread Board connection c. Multimeter – Checking of components. 2. Resistance in series, parallel and series – Parallel. 3. Capacitors & Inductors in series & Parallel. 4. Voltage sources in series, parallel and series – Parallel 5. Voltage and Current divider circuit 6. Measurement of Amplitude, Frequency & Phase difference using CRO. 7. Verification of Kirchhoff's Law. 8. Verification of Thevenin's Theorem. 9. Verification of Superposition Theorem. 10. Verification of Maximum Power Transfer Theorem. 11. RC Circuits: Time Constant. 12. Study of the Frequency Response of a Series LCR Circuit and determination of its (a) Resonant Frequency (b) Impedance at Resonance (c) Quality Factor Q (d) Bandwidth.	20		30	
		56+ 20	60	30	5

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (24 Marks)

A. Sessional Tests (1+2):	Marks:	20+20
B. Sessional Activity		
i. Surprise Test		10
ii. Seminar		10
iii. Assignment		10
iv. Attendance		10

In-semester Assessment: Marks 24

Textbooks:

1. Hayt, W. H., Kemmerly, J. E., and Durbin, S. M. (2019), *Engineering Circuit Analysis*, 9th Edition, McGraw-Hill Education, New York.
2. Mithal, G. K. (2014), *Network Analysis*, Khanna Publishers, New Delhi.
3. Chakrabarti, A. (2018), *Circuit Theory (Analysis and Synthesis)*, 8th Edition, Dhanpat Rai Publishing Company, New Delhi.
4. Boylestad, R. L. (2016), *Introductory Circuit Analysis*, 13th Edition, Pearson Education.

5. Ramesh Babu, P. (2010), *Electric Circuit Analysis*, Scitech Publications (India) Pvt. Ltd., Chennai.

E-Learning Sources

1. Basic Electrical Circuits, NPTEL, IIT Kharagpur.
2. Circuit Theory, NPTEL, IIT Madras.
3. Networks and Systems, NPTEL, IIT Roorkee.
4. Circuits and Electronics (6.002x), MIT OpenCourseWare, Massachusetts Institute of Technology.
5. Electrical Circuits Laboratory, Virtual Labs, IIT Kharagpur, Ministry of Education, Government of India.

SEMESTER-I

Course Title	: BASIC CIRCUIT THEORY AND NETWORK ANALYSIS
Course Code	: MIN-5-ELE-101
Nature of the Course	: MINOR
Total Credit assigned	: 5
Components of the course	: L-4, P-1, T-0
Distribution of Marks	: End Semester: 56 In Semester: 24 Practical:20

Course Contents

Unit	Contents	M	L	P	T
I	Basic Circuit Concepts: Voltage and Current Sources, Resistors: Fixed and Variable resistors, Construction and Characteristics, Color coding of resistors, resistors in series and parallel. Inductors: Fixed and Variable inductors, Self and mutual inductance, Faraday's law and Lenz's law of electromagnetic induction, Energy stored in an inductor, Inductance in series and parallel Capacitors: Principles of capacitance, Parallel plate capacitor, Permittivity, Definition of Dielectric Constant, Dielectric strength, Energy stored in a capacitor, Air, Paper, Mica, Teflon, Ceramic, Plastic and Electrolytic capacitor, Construction and application, capacitors in series and parallel, factors governing the value of capacitors	12	13		2
II	Circuit Analysis: Kirchhoff's Current Law (KCL), Kirchhoff's Voltage Law (KVL), Node Analysis, Mesh Analysis. DC Transient Analysis: RC Circuit- Charging and discharging with initial charge, RL Circuit with Initial Current, Time Constant, RL and RC Circuits with Sources, DC Response of Series RLC Circuits	12	13		1
III	AC Circuit Analysis: Sinusoidal Voltage and Current, Definition of Instantaneous, Peak, Peak to Peak, Root Mean Square and Average Values. Voltage-Current relationship in Resistor, Inductor and Capacitor, Phasor, Complex Impedance, Power in AC Circuits: Instantaneous Power, Average Power, Reactive Power, Power Factor. Sinusoidal Circuit Analysis for RL, RC and RLC Circuits. Resonance in Series and Parallel RLC Circuits, Frequency Response of Series and Parallel RLC Circuits, Quality (Q) Factor and Bandwidth. Passive Filters: Low Pass, High Pass, Band Pass and Band Stop	17	18		1
IV	Network Theorems: Principal of Duality, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem. AC circuit analysis using Network theorems. Two Port Networks: Impedance (Z) Parameters, Admittance (Y) Parameters.	15	16		1
V	PRACTICAL	20		30	

1. Familiarization with d. Resistance: Types and color codes e. Bread Board connection f. Multimeter – Checking of components. 2. Resistance in series, parallel and series – Parallel. 3. Capacitors & Inductors in series & Parallel. 4. Voltage sources in series, parallel and series – Parallel 5. Voltage and Current divider circuit 6. Measurement of Amplitude, Frequency & Phase difference using CRO. 7. Verification of Kirchhoff's Law. 8. Verification of Thevenin's Theorem. 9. Verification of Superposition Theorem. 10. Verification of Maximum Power Transfer Theorem. 11. RC Circuits: Time Constant. 12. Study of the Frequency Response of a Series LCR Circuit and determination of its (a) Resonant Frequency (b) Impedance at Resonance (c) Quality Factor Q (d) Bandwidth.				
	56+ 20	60	30	5

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (24 Marks)

A. Sessional Tests (1+2):	Marks:	20+20
B. Sessional Activity		
i. Surprise Test		10
ii. Seminar		10
iii. Assignment		10
iv. Attendance		10

In-semester Assessment: Marks 24

Textbooks:

1. Hayt, W. H., Kemmerly, J. E., and Durbin, S. M. (2019), *Engineering Circuit Analysis*, 9th Edition, McGraw-Hill Education, New York.
2. Mithal, G. K. (2014), *Network Analysis*, Khanna Publishers, New Delhi.
3. Chakrabarti, A. (2018), *Circuit Theory (Analysis and Synthesis)*, 8th Edition, Dhanpat Rai Publishing Company, New Delhi.
4. Boylestad, R. L. (2016), *Introductory Circuit Analysis*, 13th Edition, Pearson Education.
5. Ramesh Babu, P. (2010), *Electric Circuit Analysis*, Scitech Publications (India) Pvt. Ltd., Chennai.

E-Learning Sources

1. Basic Electrical Circuits, NPTEL, IIT Kharagpur.
2. Circuit Theory, NPTEL, IIT Madras.
3. Networks and Systems, NPTEL, IIT Roorkee.
4. Circuits and Electronics (6.002x), MIT OpenCourseWare, Massachusetts Institute of Technology.
5. Electrical Circuits Laboratory, Virtual Labs, IIT Kharagpur, Ministry of Education, Government of India.

SEMESTER- I

Course Title : INTRODUCTION TO ELECTRONICS
Course Code : MDC-3-ELE-101
Nature of the Course : MDC
Total Credit assigned : 3
Components of the course : L-2, P-1, T-0
Distribution of Marks : End Semester: 28 In Semester: 12 Practical:20

Course Contents

Unit	Contents	M	L	P	T
I	Fundamentals of Electronics: The Historical Evolution of Electronics; Electric current & Voltage; Introduction to Basic Components of Electronics and their applications (Resistor, Capacitor, Inductor); Concepts of alternating and direct current; Introduction to Semiconductor Devices and their applications (Diode, Transistor); Introduction to Integrated Circuits (ICs).	8	12		
II	Electronics in Contemporary World: Electronics for Signal conversion and Control: Rectification (Mobile charger); Amplification (Microphone and Loud Speaker); and Control (Inverters); Introduction to consumer Electronics & Electronic Home appliances: Radio, TV, Personal computer, Printer (A qualitative treatment only).	10	15		
III	Electronics in ICT: Introduction to Telephony, Telecom network spectrum, Mobile phones and Satellite communication. Role of Electronics in Education and Agriculture (Drones for survey, Smart-irrigation); Introduction to ICT tools in education: MOOCs, SWAYAM, NPTEL, NDL, Digital India, Digital Locker, Google Scholar, Shodhganga.	10	18		1
IV	PRACTICAL 1. Familiarization with a. Resistance: Types and color codes b. Bread Board connection c. Multimeter – Checking of components. 2. Resistance in series, parallel and series – Parallel. 3. Capacitors & Inductors in series & Parallel. 4. Voltage sources in series, parallel and series – Parallel 5. Verify Ohm's Law ($V = IR$) and understand the relationship between voltage, current, and resistance. 6. Voltage and Current divider circuit 7. Measurement of Amplitude, Frequency & Phase difference using CRO. 8. Study the function of diodes and their use in rectification	20		30	
		28 + 20	45	30	5

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (12 Marks)

A. Sessional Tests (1+2):	Marks:	20+20
B. Sessional Activity		
i. Surprise Test		10
ii. Attendance		10
iii. Assignment		10

In-semester Assessment:	Marks 12
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Textbooks

1. Gibilisco, S. (2011), *Teach Yourself Electricity and Electronics*, 6th Edition, McGraw-Hill Education, New York.
2. Shamieh, C. (2019), *Electronics For Dummies*, 3rd Edition, John Wiley & Sons, Hoboken, New Jersey.

E-Learning Sources

1. **Basic Electronics**, NPTEL, IIT Kharagpur.
2. **Electronic Systems for Beginners**, NPTEL.
3. **Circuits and Electronics (6.002x)**, MIT OpenCourseWare, Massachusetts Institute of Technology.
4. **Introduction to Electronics**, Khan Academy.
5. **Basic Electronics Virtual Laboratory**, Virtual Labs, IIT Kharagpur, Ministry of Education, Government of India.
6. **Electronics Tutorials**, All About Circuits Learning Platform.

SEMESTER- I

Course Title	: Fundamentals of Electricity and Domestic Wiring
Course Code	: SEC-3-ELE-101
Nature of the Course	: SEC
Total Credit assigned	: 3
Components of the course	: L-1, P-2, T-0
Distribution of Marks	: End Semester: 28 In Semester: 12 Practical:40

For SEC papers, most Theory Lectures to be clubbed with lab classes

Course Contents

Unit	Contents	M	L	P	T
I	Basics of Electricity Introduction to electricity and its applications, Voltage, Current, Resistance, Power and Energy; AC and DC supply, Single-phase electrical supply; Basic electrical symbols; Electrical energy consumption and electricity billing. Passive electrical components: Resistor, capacitor and Inductor (Concept, Types and Applications only) Transformer: working principle, types, applications in power distribution and electrical equipment Introduction to renewable energy and solar photovoltaic systems. Energy-efficient electrical appliances and energy conservation practices in households.	10	6		1
II	Domestic Wiring: Types of wires and cables used in domestic installations, Switches, sockets, plugs and lamp holders; Fuses and Miniature Circuit Breakers (MCBs), RCCB, ELCB, Distribution Boards (DB); Surface wiring and concealed wiring, Lighting circuits. Power circuits, Earthing and grounding' Importance of proper wiring practice. Estimation of domestic electrical load and selection of wiring accessories. Introduction to smart switches, motion-sensor lighting and home automation concepts.	10	12		1
III	Electrical Safety and Maintenance: Electrical hazards and accidents, Causes of electric shock, Safety precautions during electrical work Basic maintenance practices, Fire safety related to electrical installations	8	12		1
IV	PRACTICAL 1. To identify common electrical tools, wiring materials, and accessories used in domestic installations. 2. To identify common electrical and electronic components and verify their basic characteristics using measuring instruments.	40		60	

3. To perform wire stripping, insulation removal, and electrical joint making. 4. To measure voltage, current, and continuity using a multimeter. 5. To wire and test a single lamp controlled by a one-way switch. 6. To wire and test a lamp controlled from two different locations using a two-way switching arrangement. 7. To wire and test a three-pin socket outlet. 8. To wire and test an electric bell circuit. 9. To install and test a ceiling fan with regulator connection. 10. To install and test a Miniature Circuit Breaker (MCB). 11. To wire and test a simple Distribution Board (DB). 12. To study and compare the operation of MCB, RCCB and ELCB under simulated fault conditions. 13. To provide and test an earthing connection for electrical safety. 14. To perform complete wiring of a model room including lighting, fan, and power circuits. 15. To identify and rectify common faults in domestic electrical wiring. 16. To conduct an electrical safety inspection of a domestic wiring installation. 17. To study the working and applications of motion sensors, smart switches and basic home automation devices used in modern households.				
	28 + 40	30	30	3

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (12 Marks)

A. Sessional Tests (1+2): **Marks:** **20+20**

B. Sessional Activity

i. Surprise Test **10**

ii. Attendance **10**

iii. Assignment **10**

In-semester Assessment: **Marks 12**

Textbooks

1. Wadhwa, C. L. (2014), *Basic Electrical Engineering*, 3rd Edition, New Age International Publishers, New Delhi.
2. Theraja, B. L. and Theraja, A. K. (2014), *A Textbook of Electrical Technology, Vol. I (Basic Electrical Engineering)*, S. Chand Publishing, New Delhi.
3. Hughes, E., Hiley, J., Brown, K. and Smith, I. (2016), *Hughes Electrical and Electronic Technology*, 12th Edition, Pearson Education, Harlow.

4.

E-Learning Sources

1. **Basic Electrical Circuits**, NPTEL, IIT Kharagpur.
2. **Basic Electrical Engineering**, NPTEL, IIT Madras.
3. **Electrical Wiring and Installation**, SWAYAM.
4. **Electrical Machines and Power Systems**, NPTEL.
5. **Electrical Circuits Laboratory**, Virtual Labs, IIT Kharagpur, Ministry of Education, Government of India.
6. **Basic Electrical Engineering Lab**, Virtual Labs, Ministry of Education, Government of India.

SEMESTER- II

Course Title	: SEMICONDUCTOR DEVICES
Course Code	: MAJ-5-ELE-201
Nature of the Course	: MAJOR
Total Credit assigned	: 5
Components of the course	: L – 4, P – 1, T - 4
Distribution of Marks	: End Semester: 56 In Semester: 24 Practical:20

Course Contents

Unit	Contents	M	L	P	T
I	Basic Circuit Concepts Introduction to Semiconductor Materials, Crystal Structure, Planes and Miller Indices, Energy Band in Solids, Concept of Effective Mass and Density of States, Carrier Concentration in Intrinsic Semiconductors, Fermi Level for Intrinsic & Extrinsic Semiconductors, Donors, Acceptors, Dependence of Fermi Level on Temperature and Doping Concentration, Temperature Dependence of Carrier Concentrations. Carrier Transport Phenomena: Carrier Drift, Mobility, Resistivity, Hall Effect, Diffusion Process, Einstein Relation, Current Density Equation, Carrier Injection, Generation and Recombination Processes.	13	14		1
II	PN junction diode: Formation of Depletion Layer, Space Charge at a Junction, Derivation of Barrier Potential and Depletion Width, Depletion Capacitance. Concept of Linearly Graded Junction, Derivation of Diode Equation and I-V Characteristics. Zener and Avalanche Junction Breakdown Mechanism. Circuit Symbol, Characteristics and Applications of Zener diode, Tunnel diode, varactor diode, Solar cell.	13	14		1
III	Bipolar Junction Transistors (BJT): PNP and NPN Transistors, Basic Transistor Action, Emitter Efficiency, Base Transport Factor, Current Gain, Quantitative Analysis of Static Characteristics, Modes of operation, Input and Output Characteristics of CB, CE and CC Configurations. Metal Semiconductor Junctions: Ohmic and Rectifying Contacts (Idea only)	14	14		1
IV	Field Effect Transistors: JFET, Construction, Idea of Channel Formation, Pinch-Off and Saturation Voltage, Current-Voltage Output Characteristics. MOSFET, types of MOSFETs, Circuit symbols, Working and Characteristic curves of Depletion type MOSFET (both N channel and P Channel) and Enhancement type MOSFET (both N channel and P channel). Complimentary MOS (CMOS). Power Devices: Basic construction, working, symbol and applications of UJT, SCR, Triac, and Diac.	16	18		1

V	PRACTICAL 1. Identification of Semiconductor devices, its types, terminals 2. Study of the I-V Characteristics of Diode – Ordinary PN Diode. 3. Study of the I-V Characteristics of Zener Diode Diode. 4. Study of the I-V Characteristics of the CE configuration of BJT and obtain r_i , r_o , β . 5. Study of the I-V Characteristics of the Common Base Configuration of BJT and obtain r_i , r_o , α . 6. Study of the I-V Characteristics of the Common Collector Configuration of BJT and obtain voltage gain, r_i , r_o . 7. Study of the I-V Characteristics of the UJT. 8. Study of the I-V Characteristics of the SCR. 9. Study of the I-V Characteristics of JFET. 10. Study of the I-V Characteristics of MOSFET. 11. Study of Characteristics of Solar Cell	20		30	
		56 + 20	60	30	5

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (24 Marks)

A. Sessional Tests (1+2):

Marks: 20+20

B. Sessional Activity

i. Surprise Test

10

ii. Attendance

10

iii. Assignment

10

iv. Seminar

10

In-semester Assessment:

Marks 24

Textbooks

1. Sze, S. M. (2002), *Semiconductor Devices: Physics and Technology*, 2nd Edition, Wiley India Pvt. Ltd., New Delhi.
2. Streetman, B. G. and Banerjee, S. K. (2015), *Solid State Electronic Devices*, 7th Edition, Pearson Education, Noida.
3. Mehta, V. K. and Mehta, R. (2021), *Principles of Electronics*, Revised Multicolour Edition, S. Chand Publishing, New Delhi.
4. Gupta, J. B. (2021), *Electronic Devices and Circuits*, S. K. Kataria & Sons, New Delhi.

E-Learning Sources

1. **Semiconductor Devices**, NPTEL, IIT Bombay.
2. **Electronic Materials and Devices**, NPTEL, IIT Madras.
3. **Semiconductor Optoelectronics**, NPTEL, IIT Delhi.

4. **Semiconductor Devices for Integrated Circuits**, MIT OpenCourseWare, Massachusetts Institute of Technology.
5. **Semiconductor Device Physics**, NPTEL Course Archive.
6. **Semiconductor Devices and Circuits Virtual Lab**, Virtual Labs, Ministry of Education, Government of India.

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SEMESTER- II

Course Title : SEMICONDUCTOR DEVICES
Course Code : MIN-5-ELE-201
Nature of the Course : MINOR
Total Credit assigned : 5
Components of the course : L – 4, P – 1, T - 4
Distribution of Marks : End Semester: 56 In Semester: 24 Practical:20

Course Contents

Unit	Contents	M	L	P	T
I	Basic Circuit Concepts Introduction to Semiconductor Materials, Crystal Structure, Planes and Miller Indices, Energy Band in Solids, Concept of Effective Mass and Density of States, Carrier Concentration in Intrinsic Semiconductors, Fermi Level for Intrinsic & Extrinsic Semiconductors, Donors, Acceptors, Dependence of Fermi Level on Temperature and Doping Concentration, Temperature Dependence of Carrier Concentrations. Carrier Transport Phenomena: Carrier Drift, Mobility, Resistivity, Hall Effect, Diffusion Process, Einstein Relation, Current Density Equation, Carrier Injection, Generation and Recombination Processes.	13	14		1
II	PN junction diode: Formation of Depletion Layer, Space Charge at a Junction, Derivation of Barrier Potential and Depletion Width, Depletion Capacitance. Concept of Linearly Graded Junction, Derivation of Diode Equation and I-V Characteristics. Zener and Avalanche Junction Breakdown Mechanism. Circuit Symbol, Characteristics and Applications of Zener diode, Tunnel diode, varactor diode, Gunn diode, avalanche diode and Solar cell	13	14		1
III	Bipolar Junction Transistors (BJT): PNP and NPN Transistors, Basic Transistor Action, Emitter Efficiency, Base Transport Factor, Current Gain, Quantitative Analysis of Static Characteristics, Modes of operation, Input and Output Characteristics of CB, CE and CC Configurations.	14	14		1
IV	Field Effect Transistors: JFET, Construction, Idea of Channel Formation, Pinch-Off and Saturation Voltage, Current-Voltage Output Characteristics. MOSFET, types of MOSFETs, Circuit symbols, Working and Characteristic curves of Depletion type MOSFET (both N channel and P Channel) and Enhancement type MOSFET (both N channel and P channel). Complimentary MOS (CMOS). Power Devices: Basic construction, working, symbol and applications of UJT, SCR, Triac, and Diac.	16	18		1

V	PRACTICAL 1. Identification of Semiconductor devices, its types, terminals 2. Study of the I-V Characteristics of Diode – Ordinary PN Diode. 3. Study of the I-V Characteristics of Zener Diode Diode. 4. Study of the I-V Characteristics of the CE configuration of BJT and obtain r_i , r_o , β . 5. Study of the I-V Characteristics of the Common Base Configuration of BJT and obtain r_i , r_o , α . 6. Study of the I-V Characteristics of the Common Collector Configuration of BJT and obtain voltage gain, r_i , r_o . 7. Study of the I-V Characteristics of the UJT. 8. Study of the I-V Characteristics of the SCR. 9. Study of the I-V Characteristics of JFET. 10. Study of the I-V Characteristics of MOSFET. 11. Study of Characteristics of Solar Cell	20		30	
		56 + 20	60	30	5

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (24 Marks)

A. Sessional Tests (1+2):

Marks: 20+20

B. Sessional Activity

i. Surprise Test

10

ii. Attendance

10

iii. Assignment

10

iv. Seminar

10

In-semester Assessment:

Marks 24

Textbooks

1. Sze, S. M. (2002), *Semiconductor Devices: Physics and Technology*, 2nd Edition, Wiley India Pvt. Ltd., New Delhi.
2. Streetman, B. G. and Banerjee, S. K. (2015), *Solid State Electronic Devices*, 7th Edition, Pearson Education, Noida.
3. Mehta, V. K. and Mehta, R. (2021), *Principles of Electronics*, Revised Multicolour Edition, S. Chand Publishing, New Delhi.
4. Gupta, J. B. (2021), *Electronic Devices and Circuits*, S. K. Kataria & Sons, New Delhi.

E-Learning Sources

1. **Semiconductor Devices**, NPTEL, IIT Bombay.
2. **Electronic Materials and Devices**, NPTEL, IIT Madras.

3. **Semiconductor Optoelectronics**, NPTEL, IIT Delhi.
4. **Semiconductor Devices for Integrated Circuits**, MIT OpenCourseWare, Massachusetts Institute of Technology.
5. **Semiconductor Device Physics**, NPTEL Course Archive.
6. **Semiconductor Devices and Circuits Virtual Lab**, Virtual Labs, Ministry of Education, Government of India.

SEMESTER- II

Course Title : NUMBER SYSTEM AND LOGIC CIRCUITS

Course Code : MDC-3-ELE-201(B)

Nature of the Course : MDC

Total Credit assigned : 3

Components of the course : L-2, P-1, T-0

Distribution of Marks : End Semester: 28 In Semester: 12 Practical:20

Unit	Contents	M	L	P	T
I	Mathematical and Computer Logic in Nyaya Sastra: Overview of Nyaya Shastra and its relevance in the modern context, Propositional Logic, Syntax, Semantics and truth tables - Predicate Logic, Quantifiers, variables, logical connectives Inference Rules and Proofs in Mathematical Logic Number System and Codes: Decimal, Binary, Hexadecimal and Octal number systems, base conversions, Binary, octal and hexadecimal arithmetic (addition, subtraction by complement method, multiplication), Representation of signed and unsigned numbers, Binary Coded Decimal code	9	9		2
II	Logic Gates and Boolean algebra: Introduction to Boolean Algebra and Boolean operators, Truth Tables of OR, AND, NOT gate, Basic postulates and fundamental theorems of Boolean algebra, Truth tables, construction and symbolic representation of XOR, XNOR, Universal (NOR and NAND) gates	9	9		1
III	Combinational Circuits: Combinational Circuits and their applications in Nyaya Shastra, Standard representation of logic functions (SOP and POS), Karnaugh map minimization, Encoder and Decoder, Multiplexers and Demultiplexers, Implementing logic functions with multiplexer, binary Adder, binary subtractor.	10	12		2
IV	PRACTICALS - To study and verify basic gates using IC - To study and verify Universal gates using IC - To study and verify XOR and XNOR gate using IC - To Implement digital circuits from logic expressions - To study Multiplexer circuit - To Study Demultiplexer Circuit - To design a Full adder - To design a Full subtractor - To study and verify BCD-to-7 Segment decoder - To Study and verify priority encoder	20		30	
		28 + 20	30	30	4

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (12 Marks)

A. Sessional Tests (1+2):	Marks:	20+20
B. Sessional Activity		
i. Surprise Test		10
ii. Attendance		10
iii. Assignment		10

In-semester Assessment:	Marks 12
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Textbooks

1. Mano, M. M. and Ciletti, M. D. (2018), *Digital Design*, 6th Edition, Pearson Education, Noida.
2. Jain, R. P. (2015), *Modern Digital Electronics*, 5th Edition, McGraw Hill Education (India) Pvt. Ltd., Noida.
3. Maini, A. K. (2007), *Digital Electronics: Principles, Devices and Applications*, John Wiley & Sons, New Delhi.

E-Learning Sources

1. **Digital Circuits**, NPTEL, IIT Kharagpur.
2. **Digital Electronic Circuits**, NPTEL, IIT Roorkee.
3. **Digital Systems**, NPTEL, IIT Madras.
4. **Computation Structures**, MIT OpenCourseWare, Massachusetts Institute of Technology.
5. **Digital Logic Design Virtual Lab**, Virtual Labs, IIT Kharagpur.
6. **Digital Electronics**, SWAYAM-NPTEL Course Archive.

SEMESTER- II

Course Code	: SEC-3-ELE-201		
Course Title	: Solar Installation and Maintenance		
Nature of the Course	: SEC		
Total Credit assigned	: 3		
Distribution of Credits	: L- 1 , P-2, T-0		
Distribution of Marks	: End Semester: 28	In Semester: 12	Practical:40

For SEC papers, most Theory Lectures to be clubbed with lab classes

Unit	Contents	M	L	P	T
I	Solar Energy: Renewable and non-renewable energy sources; Need and importance of renewable energy; Solar energy and its applications; Solar radiation and solar energy potential; Advantages and limitations of solar energy. Solar cells, modules and panels; Construction and working of solar photovoltaic panels; Panel ratings and specifications; Overview of solar photovoltaic power generation.	10	10		
II	Solar Installation: Batteries used in solar installations; Charge controllers and their functions; Inverters and their applications; Mounting structures, cables and connectors used in solar installations. Off-grid solar power systems; On-grid solar power systems; Hybrid solar power systems; Site selection for solar installations; Panel orientation and tilt angle; Series and parallel connection of solar panels; Basic wiring practices in solar installations. Load estimation for small solar installations.	10	12		
III	Solar Maintenance and Safety: Routine inspection and maintenance of solar panels; Cleaning and upkeep of solar installations; Battery maintenance practices. Common faults in solar power systems; Fault identification and basic troubleshooting. Safety precautions during installation, operation and maintenance; Environmental and economic benefits of solar power systems.	8	10		
V	PRACTICAL 1. To identify various components of a solar photovoltaic system. 2. To study the specifications and ratings of solar panels.	40		30	

3. To measure the voltage and current output of a solar panel under different conditions. 4. To perform series and parallel connections of solar panels. 5. To identify and test batteries used in solar power systems. 6. To study the operation of a solar charge controller. 7. To connect and test a solar panel, charge controller and battery system. 8. To install and test a solar-powered lighting system. 9. To study the operation of an inverter used in a solar power system. 10. To study the performance of a solar power system under different loading conditions. 11. To identify and rectify common faults in a solar power system. 12. To perform cleaning and preventive maintenance of solar panels. 13. To assess the effect of panel orientation and tilt angle on solar panel output. 14. To install and test a small off-grid solar power system. 15. To prepare a maintenance checklist for a solar installation. 16. To conduct a safety inspection of a solar power installation. 17. To measure the effect of shading on the output of a solar panel.				
	28 + 40	45	30	

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (12 Marks)

A. Sessional Tests (1+2):	Marks:	20+20
B. Sessional Activity		
i. Surprise Test		10
ii. Attendance		10
iii. Assignment		10

In-semester Assessment:

Marks 12

Textbooks

1. Solanki, C. S. (2015), *Solar Photovoltaics: Fundamentals, Technologies and Applications*, 3rd Edition, PHI Learning Pvt. Ltd., New Delhi.
2. Dunlop, J. P. (2012), *Photovoltaic Systems*, 3rd Edition, American Technical Publishers, Illinois.
3. Rai, G. D. (2017), *Non-Conventional Energy Sources*, 6th Edition, Khanna Publishers, New Delhi.

E-Learning Sources

1. **Solar Photovoltaics: Fundamentals, Technology and Applications**, NPTEL, IIT Bombay.

2. **Solar Energy Engineering and Technology**, NPTEL, IIT Kharagpur.
3. **Non-Conventional Energy Resources**, NPTEL, IIT Madras.
4. **Solar Energy**, SWAYAM-NPTEL.
5. **Solar Energy Engineering**, Delft University of Technology (TU Delft), edX.
6. **Solar PV Virtual Laboratory**, Virtual Labs, Ministry of Education, Government of

SEMESTER-III

Course Title	: ANALOG ELECTRONICS
Course Code	: MAJ-4-ELE-301
Nature of the Course	: MAJOR (DSC-III)
Total Credit assigned	: 4
Distribution of Credits	: L- 1 , P-1, T-0
Distribution of Marks	: End Semester: 42 In Semester: 18 Practical:20

Course Contents

Unit	Contents	M	L	P	T
I	Diode Circuits: Ideal diode, piecewise linear equivalent circuit, dc load line analysis, Quiescent (Q) point. Clipping and clamping circuits. Rectifiers: HWR, FWR (center tapped and bridge). Circuit diagrams, working and waveforms, ripple factor & efficiency, comparison. Filters: types, circuit diagram and explanation of shunt capacitor filter with waveforms. Zener diode regulator: circuit diagram and explanation for load and line regulation, disadvantages of Zener diode regulator.	12	13		1
II	Bipolar Junction Transistor: Review of CE, CB Characteristics and regions of operation. Transistor biasing, DC load line, operating point, thermal runaway, Fixed bias without and with RE, collector to base bias, voltage divider bias and emitter bias (+VCC and -VEE bias), circuit diagrams and their working. Transistor as a switch, circuit and working. BJT amplifier (CE), dc and ac load line analysis, hybrid model of CE configuration, Quantitative study of the frequency response of a CE amplifier, Effect on gain and bandwidth for Cascaded CE amplifiers (RC coupled)	14	16		1
III	MOSFET Circuits: Review of Depletion and Enhancement MOSFET, Biasing of MOSFETs, Small Signal Parameters, Common Source amplifier circuit analysis, CMOS circuits.	08	08		1
IV	Feedback Amplifiers: Concept of feedback, negative and positive feedback, advantages and disadvantages of negative feedback, Barkhausen criteria for oscillations, Study of phase shift oscillator, Wein Bridge Oscillator. Power Amplifiers: Difference between voltage and power amplifier, classification of power amplifiers, Class A, Class B, Class C and their comparisons.	08	08		
V	PRACTICAL 1. Study of the half wave rectifier and Full wave rectifier. 2. Study of power supply using C filter and Zener diode. 3. Designing and testing of 5V/9 V DC regulated power supply and find its load-regulation 4. Study of clipping and clamping circuits. 5. Study of Fixed Bias, Voltage divider bias configuration for	20		30	

	transistors. 6. Designing of a Single Stage CE amplifier. 7. Study of Class A, B Power Amplifier. 8. Study of the Wein Bridge Oscillator 10. Study of the Phase Shift Oscillator				
		42 + 20	45	30	5

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (18 Marks)

A. Sessional Tests (1+2):

Marks: 20+20

B. Sessional Activity

i. Surprise Test

10

ii. Attendance

10

iii. Assignment

10

iv. Seminar

10

In-semester Assessment:

Marks 18

Textbooks

1. Boylestad, R. L. and Nashelsky, L. (2019), *Electronic Devices and Circuit Theory*, 11th Edition, Pearson Education, Noida.
2. Millman, J. and Halkias, C. C. (2015 Reprint), *Electronic Devices and Circuits*, Tata McGraw-Hill Education, New Delhi.
3. Mehta, V. K. and Mehta, R. (2021), *Principles of Electronics*, Revised Multicolour Edition, S. Chand Publishing, New Delhi.
1. Neamen, D. A. (2010), *Electronic Circuit Analysis and Design*, 3rd Edition, McGraw-Hill Education.
2. Theraja, B. L. and Theraja, A. K. (2014), *A Textbook of Electrical Technology, Vol. IV (Electronics)*, S. Chand Publishing, New Delhi.

E-Learning Sources

1. **Basic Electronics**, NPTEL, IIT Kharagpur.
2. **Analog Electronic Circuits**, NPTEL, IIT Madras.
3. **Electronic Circuits**, NPTEL, IIT Kharagpur.
4. **Circuits and Electronics (6.002x)**, MIT OpenCourseWare, Massachusetts Institute of Technology.
5. **Analog Electronics Lab**, Virtual Labs, IIT Kharagpur.
6. **Electronic Devices and Circuits**, SWAYAM-NPTEL Course Archive.

SEMESTER-III

Course Title	: DIGITAL ELECTRONICS		
Course Code	: MAJ-4-ELE-302		
Nature of the Course	: MAJOR (DSC-IV)		
Total Credit assigned	: 4		
Components of the course	: L-3, P-1, T-5		
Distribution of Marks	: End Semester: 42	In Semester: 18	Practical:20

Course Contents

Unit	Contents	M	L	P	T
I	Mathematical and Computer Logic in Nyaya Shastra: Overview of Nyaya Shastra and its relevance in the modern context, Propositional Logic: Syntax, semantics, and truth tables, Predicate Logic, Quantifiers, variables, and logical connectives, Inference Rules and Proofs in Mathematical Logic. Number System and Codes: Decimal, Binary, Hexadecimal and Octal number systems, base conversion, Binary, octal and hexadecimal arithmetic (addition, subtraction by complement method, multiplication), representation of signed and unsigned numbers, Binary Coded Decimal Logic Gates and Boolean algebra: Introduction to Boolean Algebra and Boolean operators, Truth Tables of OR, AND, NOT, Basic postulates and fundamental theorems of Boolean algebra, Truth tables, construction and symbolic representation of XOR, XNOR, Universal (NOR and NAND) gates. Digital Logic families: Fan-in, Fan out, Noise Margin, Power Dissipation, Figure of merit, Speed power product, TTL and CMOS families and their comparison	14	13		2
II	Combinational Logic Analysis and Design: Review of Combinational Circuits and their applications in Nyaya Shastra, Standard representation of logic functions (SOP and POS), Karnaugh map minimization, Encoder and Decoder, Multiplexers and Demultiplexers, Implementing logic functions with multiplexer, binary Adder, binary subtractor, parallel adder/subtractor	12	14		2
III	Sequential logic design: Sequential Circuits and their relevance in Nyaya Shastra methodologies, Latches and Flip flops: S-R Flip flop, J-K Flip flop, T and D type Flip flop, Clocked and edge triggered Flip flops, master slave flip flop, Registers, Counters (synchronous And asynchronous and modulo-N), State Table, State Diagrams, Ring counter and Johnson counter.	16	18		1

	Integration with Modern Logical Systems: Comparative study of Nyaya Shastra with Western philosophical logic, Examining the intersections and divergences between Nyaya Shastra and contemporary logic, Contemporary applications of Nyaya Shastra principles in logical analysis Programmable Logic Devices: Basic concepts- ROM, PLA, PAL, CPLD, FPGA				
IV	PRACTICAL 1. To verify and design AND, OR, NOT and XOR gates using NAND gates. 2. To convert a Boolean expression into logic gate circuit and assemble it using logic gate IC's. 3. Design a Half and Full Adder. 4. Design a Half and Full Subtractor. 5. Design a BCD to seven segment display driver. 6. Design a 4:1 Multiplexer using gates. 7. Design a 1:4 De-Multiplexer using gates. 8. To build a Flip- Flop Circuits using elementary gates. (RS, D-type). 9. Design a counter using D/T/JK Flip-Flop. 10. Design a shift register and study Serial and parallel shifting of data.	20		30	
		42 + 20	45	30	5

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (18 Marks)

A. Sessional Tests (1+2):	Marks:	20+20
B. Sessional Activity		
i. Surprise Test		10
ii. Attendance		10
iii. Assignment		10
iv. Seminar		10

In-semester Assessment: Marks 18

Textbooks

1. Jain, R. P. (2015), *Modern Digital Electronics*, 5th Edition, McGraw Hill Education (India) Pvt. Ltd., Noida.
2. Mano, M. M. and Ciletti, M. D. (2018), *Digital Design*, 6th Edition, Pearson Education, Noida.
3. Anand Kumar, A. (2016), *Fundamentals of Digital Circuits*, 4th Edition, PHI Learning Pvt. Ltd., New Delhi.

E-Learning Sources

1. **Digital Circuits**, NPTEL, IIT Kharagpur.
2. **Digital Electronic Circuits**, NPTEL, IIT Roorkee.
3. **Digital System Design**, NPTEL, IIT Madras.
4. **Computation Structures**, MIT OpenCourseWare, Massachusetts Institute of Technology.
5. **Digital Logic Design Virtual Lab**, Virtual Labs, IIT Kharagpur.
6. **Digital Electronics**, SWAYAM-NPTEL Course Archive.

SEMESTER-III

Course Title : MATHEMATICAL FOUNDATION FOR ELECTRONICS
Course Code : MIN-2-ELE-301(A)
Nature of the Course : MINOR (DSE-III: Major Students)
Component of the Course : L-2, P-0 T-0
Total Credit assigned : 2
Distribution of Marks : End Semester: 28 In Semester: 12
Syllabus Contents

Unit	Contents	M	L	P	T
I	Vedas and Śulbasūtras Place value system, Conception of zero, Origins of geometry, Āryabhaṭīya of Āryabhaṭa, Brāhmasphuṭasiddhānta of Brahmagupta, Līlāvati and Bījagaṇita of Bhāskarācārya, The Kerala school – Mādhava, Nīlakaṇṭha, Jyeṣṭhadeva, etc. Mathematical proofs given by Bhāskara-I, Nīlakaṇṭha, Jyeṣṭhadeva, Munīśvara, etc., An overview of the major teacher-disciple mathematical lineages of India, Transmission of mathematical knowledge between India and other civilizations.	6	5		
II	Ordinary Differential Equations: First Order Ordinary Differential Equations, Basic Concepts, Separable Ordinary Differential Equations, Exact Ordinary Differential Equations, Linear Ordinary Differential Equations. Second Order homogeneous Differential Equations.	7	7		1
III	Matrices: Introduction to Matrices, System of Linear Algebraic Equations, Gaussian Elimination Method, Gauss-Seidel Method. Eigen Values and Eigen Vectors, Linear Transformation, Properties of Eigen Values and Eigen Vectors, Cayley-Hamilton Theorem, Diagonalization, Powers of a Matrix. Real and Complex Matrices, Symmetric, Skew Symmetric, Orthogonal Quadratic Form, Hermitian, Skew Hermitian, Unitary Matrices.	9	10		2
IV	Sequences and series: Sequences, Limit of a sequence, Convergence, Divergence and Oscillation of a sequence, Infinite series.	6	8		2
		28	30		5

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (12 Marks)

A. Sessional Tests (1+2):	Marks:	20+20
B. Sessional Activity		
i. Surprise Test		10
ii. Attendance		10
iii. Assignment		10

In-semester Assessment:

Marks 12

Textbooks

1. Kreyszig, E. (2011), *Advanced Engineering Mathematics*, 10th Edition, John Wiley & Sons, Hoboken, New Jersey.
2. Jain, R. K. and Iyengar, S. R. K. (2016), *Advanced Engineering Mathematics*, 5th Edition, Narosa Publishing House, New Delhi.
3. Grewal, B. S. (2017), *Higher Engineering Mathematics*, 44th Edition, Khanna Publishers, New Delhi.

E-Learning Sources

1. **Mathematics for Engineers**, NPTEL, IIT Madras.
2. **Advanced Engineering Mathematics**, NPTEL, IIT Kharagpur.
3. **Linear Algebra**, MIT OpenCourseWare, Massachusetts Institute of Technology.
4. **Differential Equations**, MIT OpenCourseWare, Massachusetts Institute of Technology.
5. **Engineering Mathematics**, SWAYAM-NPTEL.
6. **Essence of Linear Algebra**, 3Blue1Brown (Educational Video Series).

SEMESTER-III

Course Title : DIGITAL ELECTRONICS
Course Code : MIN-2-ELE-302
Nature of the Course : MINOR (DSE-IV: Non-Major students)
Total Credit assigned : 2
Component of the Course : L-2, P-0, T-0
Distribution of Marks : End Semester: 28 In Semester: 12

Syllabus Contents

Unit	Contents	M	L	P	T
I	Mathematical and Computer Logic in Nyaya Shastra: Overview of Nyaya Shastra and its relevance in the modern context, Propositional Logic: Syntax, semantics, and truth tables, Predicate Logic, Quantifiers, variables, and logical connectives, Inference Rules and Proofs in Mathematical Logic Number System and Codes: Decimal, Binary, Hexadecimal and Octal number systems, base conversions, Binary, octal and hexadecimal arithmetic (addition, subtraction by complement method, multiplication), representation of signed and unsigned numbers, Binary Coded Decimal code Logic Gates and Boolean algebra: Introduction to Boolean Algebra and Boolean operators, Truth Tables of OR, AND, NOT; Basic postulates and fundamental theorems of Boolean algebra, Truth tables, construction and symbolic representation of XOR, XNOR, Universal (NOR and NAND) gates.	9	10	8	2
II	Combinational Logic Analysis and Design: Review of Combinational Circuits and their applications in Nyaya Shastra, Standard representation of logic functions (SOP and POS), Karnaugh map minimization, Encoder and Decoder, Multiplexers and Demultiplexers, Implementing logic functions with multiplexer, binary Adder, binary subtractor, parallel adder/subtractor	9	10		1
III	Sequential logic design: Sequential Circuits and their relevance in Nyaya Shastra methodologies, Latches and Flip flops: S-R Flip flop, J-K Flip flop, T and D type Flip flop, Clocked and edge triggered Flip flops, master slave flip flop, Registers, Counters (synchronous And asynchronous and modulo-N), State Table, State Diagrams, Ring counter and Johnson counter.	10	10		
		28	30		

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (12 Marks)

A. Sessional Tests (1+2):

Marks:

20+20

B. Sessional Activity

i. Surprise Test	10
ii. Attendance	10
iii. Assignment	10

In-semester Assessment:

Marks 12

Textbooks

1. Jain, R. P. (2015), *Modern Digital Electronics*, 5th Edition, McGraw Hill Education (India) Pvt. Ltd., Noida.
2. Mano, M. M. and Ciletti, M. D. (2018), *Digital Design*, 6th Edition, Pearson Education, Noida.
3. Anand Kumar, A. (2016), *Fundamentals of Digital Circuits*, 4th Edition, PHI Learning Pvt. Ltd., New Delhi.

E-Learning Sources

1. **Digital Circuits**, NPTEL, IIT Kharagpur.
2. **Digital Electronic Circuits**, NPTEL, IIT Roorkee.
3. **Digital System Design**, NPTEL, IIT Madras.
4. **Computation Structures**, MIT OpenCourseWare, Massachusetts Institute of Technology.
5. **Digital Logic Design Virtual Lab**, Virtual Labs, IIT Kharagpur.
6. **Digital Electronics**, SWAYAM-NPTEL Course Archive.

SEMESTER-III

Course Title	: FUNDAMENTALS OF ELECTRONIC MEASUREMENTS
Course Code	: MDC-3-ELE-301
Nature of the Course	: MDC
Total Credit assigned	: 3
Distribution of Credits	: L-3 ,P-0, T- 0
Distribution of Marks	: End Semester: 42 In Semester: 18

Unit	Contents	M	L	P	T
I	Measurement Basics: Definition and importance of measurement, Units and standards, Error (Gross error, systematic error, absolute error and relative error), Types of measurements: analog and digital Measurement Instruments: Analog and digital multimeters, Oscilloscopes, Signal generators, Power supplies (Functional block diagram, applications, advantages and disadvantages only)	13	14		
II	Transducers and sensors: Introduction to sensors and transducers, characteristics of transducers, Classification of transducers, active & passive transducers, Analog and Digital Sensors, Types of sensors (Basic Principle of operation and application only): Temperature, Pressure, Velocity, Light.	12	14		1
III	Data Acquisition Systems: Definition and importance of data acquisition, Components of data acquisition systems, Types (Data Loggers, Data Acquisition Devices, Modular Data Acquisition Systems), [Basic concepts, applications, comparison only] Data Communication Protocols: Serial communication standards (e.g., UART, SPI, I2C), Bus protocols (e.g., CAN, USB), Wireless communication standards (e.g., Bluetooth, Zigbee, WiFi) [Basic concepts, applications, comparison]	17	17		1
		42	45		

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (18 Marks)

A. Sessional Tests (1+2):	Marks:	20+20
B. Sessional Activity		
i. Surprise Test		10
ii. Attendance		10
iii. Assignment		10

In-semester Assessment:

Marks 18

Textbooks

1. Helfrick, A. D. and Cooper, W. D. (2015 Reprint), *Modern Electronic Instrumentation and Measurement Techniques*, Prentice Hall of India (PHI Learning), New Delhi.
2. Sawhney, A. K. and Sawhney, P. (2023), *A Course in Electrical and Electronic Measurements and Instrumentation*, 21st Edition, Dhanpat Rai & Co., New Delhi.
3. Morris, A. S. and Langari, R. (2016), *Measurement and Instrumentation: Theory and Application*, 2nd Edition, Academic Press, Elsevier.

E-Learning Sources

1. Electrical Measurements and Electronic Instruments, NPTEL, IIT Kharagpur.
2. Industrial Instrumentation, NPTEL, IIT Kharagpur.
3. Measurements and Instrumentation, NPTEL, IIT Roorkee.
4. Electronic Interfaces, MIT OpenCourseWare, Massachusetts Institute of Technology.
5. Virtual Electrical and Electronic Measurements Laboratory, Virtual Labs, IIT Kharagpur.
6. Instrumentation and Measurement, SWAYAM-NPTEL Course Archive.

SEMESTER-III

Course Title	: PROGRAMMING IN C
Course Code	: SEC-3-ELE-301 (A)
Nature of the Course	: SEC
Total Credit assigned	: 3
Components of the course	: L-1, P-2, T-0
Distribution of Marks	: End Semester: 28 In Semester: 12 Practical:40

For SEC papers, most Theory Lectures to be clubbed with lab classes

Syllabus Contents

Unit	Contents	M	L	P	T
I	C Programming Language: Introduction, Importance of C, Character set, Tokens, keywords, identifier, constants; basic data types, variables: declaration & assigning values, Structure of C program Operators: Arithmetic operators, relational operators, logical operators, assignment operators, increment and decrement operators, conditional operators, bit wise operators, Expressions and evaluation of expressions, Type cast operator, implicit conversions, precedence of operators. Arrays concepts: declaration, accessing elements, storing elements, two-dimensional and multidimensional arrays; Input output statement and library functions (math and string related functions)	10	12		
II	Decision making, branching & looping: Decision making, branching and looping: if, if-else, else-if, switch statement, break, for loop, while loop and do loop. Functions: Defining functions, function arguments and passing, returning values from functions	10	10		
III	Searching and sorting: Insertion sort, selection sort, bubble sort, merge sort, linear Search, binary search	8	8		
IV	PRACTICAL 1. Generate the Fibonacci series up to the given limit N and also print the number of elements in the series. 2. Find minimum and maximum of N numbers. 3. Find the GCD of two integer numbers. 4. Calculate factorial of a given number. 5. Find all the roots of a quadratic equation $Ax^2 + Bx + C = 0$ for non – zero coefficients A, B and C. Else report error. 6. Calculate the value of sin (x) and cos (x) using the series. Also print sin (x) and cos (x) value using library function.	40		30	

7. Generate and print prime numbers up to an integer N. 8. Sort given N numbers in ascending order. 9. Create a stack and perform Pop, Push, Traverse operations on the stack using Linear Linked list 10. Create a Binary Tree to perform Tree traversals (Preorder, Postorder, Inorder) using the concept of recursion. 11. Implement binary search tree using linked lists. Compare its time complexity over that of linear search. 12. Implement Insertion sort, Merge sort, Bubble sort, Selection sort. 13. Find the sum & difference of two matrices of order MxN and PxQ. 14. Find the product of two matrices of order MxN and PxQ. 15. Find the transpose of given MxN matrix. 16. Find the sum of principle and secondary diagonal elements of the given MxN matrix. 17. Calculate the subject wise and student wise totals and store them as a part of the structure.				
	28 + 40	30	30	

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (12 Marks)

A. Sessional Tests (1+2):	Marks:	20+20
B. Sessional Activity		
i. Surprise Test		10
ii. Attendance		10
iii. Assignment		10

In-semester Assessment:	Marks 12
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Textbooks

1. Balagurusamy, E. (2020), *Programming in ANSI C*, 8th Edition, McGraw Hill Education (India) Pvt. Ltd., Noida.
2. Balagurusamy, E. (2022), *Object Oriented Programming with C++*, 8th Edition, McGraw Hill Education (India) Pvt. Ltd., Noida.
3. Prata, S. (2014), *C Primer Plus*, 6th Edition, Addison-Wesley Professional, Boston.

E-Learning Sources

1. **Programming in C**, NPTEL, IIT Kharagpur.
2. **Introduction to Programming in C**, NPTEL, IIT Kanpur.
3. **Programming, Data Structures and Algorithms using C**, NPTEL, IIT Madras.

SEMESTER-III

Course Title	: Electrical and Solar Power: Field Practices
Course Code	: SEC-3-ELE-301 (B)
Nature of the Course	: SEC
Total Credit assigned	: 3
Components of the course	: L-1, P-2, T-0
Distribution of Marks	: End Semester: 28 In Semester: 12 Practical:40

For SEC papers, most Theory Lectures to be clubbed with lab classes

Syllabus Contents

Unit	Contents	M	L	P	T
I	Electrical and Solar System Planning: Overview of rooftop solar installations, Electrical and solar installations in residential, commercial and institutional buildings. Introduction to solar power system sizing; Selection of solar panels, batteries and inverters for small domestic loads	10	12		
II	Installation, Estimation and Documentation: Site survey for electrical and solar installations; Observation of rooftop conditions and installation requirements; Panel orientation and tilt angle considerations. Preparation of simple wiring layouts and solar installation layouts; Estimation of materials required for electrical and solar installations. Preparation of cost estimation sheets, maintenance records and installation reports; Introduction to quotations and service documentation.	10	10		
III	Maintenance, Safety and Entrepreneurship: Preventive and corrective maintenance of electrical and solar installations; Common faults in wiring systems, inverters, batteries and solar panels. Safety practices during inspection, installation and maintenance work; Use of personal protective equipment (PPE). Introduction to entrepreneurship opportunities in electrical wiring, solar installation and maintenance services.	8	8		
IV	FIELD VISIT Students shall undertake field visits to Electrical Substations/Grid Stations, Power Generation Plants, Solar Power Plants, Rooftop Solar Installations, and Domestic or Commercial Electrical Installation sites. The visits are intended to provide practical exposure to electrical power generation, transmission, distribution, solar energy systems, installation practices, maintenance procedures, and safety measures adopted in real-world environments. As part of the field-study component, students shall:	40		30	

1. Conduct a household electrical load survey and prepare a load chart.				
2. Prepare a technical report on an electrical substation or grid station visited during the course.				
3. Prepare a technical report on a power generation plant visited during the course.				
4. Prepare a technical report on a solar power plant and rooftop solar installation visited during the course.				
5. Prepare and present a consolidated field-study report incorporating observations, findings, and recommendations based on all field visits undertaken during the semester.				
	28 + 40	30	30	

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (12 Marks)

A. Sessional Tests (1+2):

Marks: 20+20

B. Sessional Activity

i. Surprise Test

10

ii. Attendance

10

iii. Assignment

10

In-semester Assessment:

Marks 12

Textbooks

1. Wadhwa, C. L. (2014), *Basic Electrical Engineering*, 3rd Edition, New Age International Publishers, New Delhi.
2. Theraja, B. L. and Theraja, A. K. (2014), *A Textbook of Electrical Technology, Vol. I*, S. Chand Publishing, New Delhi.
3. Solanki, C. S. (2015), *Solar Photovoltaics: Fundamentals, Technologies and Applications*, 3rd Edition, PHI Learning Pvt. Ltd., New Delhi.

E-Learning Sources

1. **Solar Photovoltaics: Fundamentals, Technology and Applications**, NPTEL, IIT Bombay.
2. **Solar Energy Engineering and Technology**, NPTEL, IIT Kharagpur.
3. **Non-Conventional Energy Resources**, NPTEL, IIT Madras.
4. **Solar Energy**, SWAYAM-NPTEL.
5. **Solar PV Virtual Laboratory**, Virtual Labs, Ministry of Education, Government of India.
6. **Renewable Energy and Green Building Entrepreneurship**, NPTEL, IIT Roorkee.

SEMESTER-IV

Course Title : OPERATIONAL AMPLIFIERS AND APPLICATIONS
Course Code : MAJ-4-ELE-401
Nature of the Course : MAJOR
Total Credit assigned : 4
Components of the course : L-4, P-0, T-0
Distribution of Marks : End Semester: 56 In Semester: 24

Syllabus Contents

Unit	Contents	M	L	P	T
I	Basic Operational Amplifier: Concept of differential amplifiers (Dual input balanced and unbalanced output), constant current bias, current mirror, block diagram of an operational amplifier (IC 741) Op-Amp parameters: input offset voltage, input offset current, input bias current, differential input resistance, input capacitance, offset voltage adjustment range, input voltage range, common mode rejection ratio, slew rate, supply voltage rejection ratio.	16	18		2
II	Op-Amp Circuits: Open and closed loop configuration, Frequency response of an op-amp in open loop and closed loop configurations; Inverting, Non-inverting, Summing and difference amplifier; Integrator, Differentiator, Voltage to current converter, Current to voltage converter; Comparators: Basic comparator, Level detector, Voltage limiters, Schmitt Trigger; Signal generators: Phase shift oscillator, Wein bridge oscillator, Square wave generator, triangle wave generator, Saw tooth wave generator, Voltage controlled oscillator	20	18		1
III	Multivibrators (IC 555): Block diagram, Astable and monostable multivibrator circuit, Applications of Monostable and Astable multivibrators, Phase locked loops (PLL): Block diagram, phase detectors	10	12		2
IV	Signal Conditioning circuits: Sample and hold systems Active filters: First order low pass and high pass butterworth filter, Second order filters, Band pass filter, Band reject filter, Log and Anti-log filters	10	12		
		56	60		5

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (24 Marks)

A. Sessional Tests (1+2):

Marks:

20+20

B. Sessional Activity

i. Surprise Test	10
ii. Attendance	10
iii. Assignment	10
iv. Seminar	10

In-semester Assessment:

Marks 24

Textbooks

1. Gayakwad, R. A. (2015), *Op-Amps and Linear Integrated Circuits*, 4th Edition, Pearson Education India, Noida.
2. Roy Choudhury, D. and Jain, S. (2018), *Linear Integrated Circuits*, 5th Edition, New Age International Publishers, New Delhi.
3. Coughlin, R. F. and Driscoll, F. F. (1998), *Operational Amplifiers and Linear Integrated Circuits*, 6th Edition, Prentice Hall of India, New Delhi.

E-Learning Sources

1. **Analog Electronic Circuits**, NPTEL, IIT Madras.
2. **Integrated Circuits, MOSFETs, Op-Amps and their Applications**, NPTEL, IIT Madras.
3. **Analog Circuits**, MIT OpenCourseWare, Massachusetts Institute of Technology.
4. **Operational Amplifiers (Precision Labs Series)**, Texas Instruments.
5. **Operational Amplifier Applications**, Analog Devices Education Library.
6. **Linear Integrated Circuits**, NPTEL Course Archive.

SEMESTER-IV

Course Title	: SIGNALS AND SYSTEMS
Course Code	: MAJ-4-ELE-402
Nature of the Course	: MAJOR
Total Credit assigned	: 3+1
Components of the course	: L-3, P-1, T-0
Distribution of Marks	: End Semester: 42 In Semester: 18 Practical: 20

Syllabus Contents

Unit	Contents	M	L	P	T
I	Signals: Continuous and Discrete time signals, Exponential and sinusoidal signals, Impulse, unit step, ramp functions. Systems: Continuous-Time and Discrete-Time Systems, Basic System Properties Linear Time -Invariant Systems: Discrete time LTI systems, basic definition of the Convolution, Continuous time LTI systems, Convolution integral, Properties of LTI systems: Commutative, Distributive, Associative property etc., LTI systems with and without memory, Invariability, Causality, Stability, Unit Step response	18	18		2
II	Fourier Series Representation of Periodic Signals: Continuous-Time periodic signals, Convergence of the Fourier series, Properties of continuous-Time Fourier series, Discrete-Time periodic signals, Properties of Discrete-Time Fourier series.	14	16		1
III	Laplace Transform: Laplace Transform, Inverse Laplace Transform, Properties of the Laplace Transform, Laplace Transform Pairs, Laplace Transform for signals, Laplace Transform of derivative and integral, Laplace Transform Methods in Circuit Analysis, Impulse and Step response of RL, RC and RLC circuits.	10	11		2
IV	Practical: 1. Generation of Signals: continuous time and discrete time signals 2. Time shifting and time scaling of signals. 3. Plot Sinusoidal and exponential Signal 4. To plot Periodic, aperiodic signal 5. Plot Unit Impulse, Unit step, Unit ramp signals 6. Fourier series representation of continuous time signals. 7. To perform Convolution of two Signals 8. Laplace transform of continuous time signals.	20		30	
		42 + 20	45		5

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (18 Marks)

A. Sessional Tests (1+2):

Marks: 20+20

B. Sessional Activity

i. Surprise Test	10
ii. Attendance	10
iii. Assignment	10
iv. Seminar	10

In-semester Assessment:**Marks 18****Textbooks**

1. Oppenheim, A. V., Willsky, A. S. and Nawab, S. H. (1997), *Signals and Systems*, 2nd Edition, Prentice Hall of India, New Delhi.
2. Nagoor Kani, A. (2017), *Signals and Systems*, 3rd Edition, McGraw Hill Education (India) Pvt. Ltd., Noida.
3. Rao, B. P. Lathi (2018 Reprint), *Linear Systems and Signals*, 3rd Edition, Oxford University Press, New Delhi.
4. Haykin, S. and Van Veen, B. (2007), *Signals and Systems*, 2nd Edition, John Wiley & Sons.
5. Anand Kumar, A. (2013), *Signals and Systems*, 3rd Edition, PHI Learning Pvt. Ltd., New Delhi.

E-Learning Sources

1. **Signals and Systems**, NPTEL, IIT Kharagpur.
2. **Signals and Systems**, NPTEL, IIT Madras.
3. **Continuous-Time Signals and Systems**, NPTEL.
4. **Discrete-Time Signal Processing**, NPTEL.
5. **Signals and Systems**, MIT OpenCourseWare, Massachusetts Institute of Technology.
6. **Signal Processing Virtual Laboratory**, Virtual Labs, IIT Kharagpur.

SEMESTER-IV

Course Title	: ELECTRONIC INSTRUMENTATION
Course Code	: MAJ-4-ELE-403
Nature of the Course	: MAJOR
Total Credit assigned	: 4
Components of the course	: L-3, P-1, T-0
Distribution of Marks	: End Semester: 42 In Semester: 18 Practical: 20

Syllabus Contents

Unit	Contents	M	L	P	T
I	Qualities of Measurement: Specifications of instruments, their static and dynamic characteristics, Error (Gross error, systematic error, absolute error and relative error). Basic Measurement Instruments: PMMC and MI instrument, galvanometer, DC measurement - ammeter, voltmeter, ohm meter, AC measurement, digital multimeters, digital frequency meter (different modes). Probes and connectors: Definition and types of probes, identifying electronic connectors – audio and video, RF/Coaxial, USB etc.	12	8		0
II	Measurement of Resistance and Impedance: Low Resistance: Kelvin's double bridge method, Medium Resistance by Voltmeter Ammeter method, Wheatstone bridge method, A.C. bridges, Measurement of Self Inductance and Anderson's bridge, Measurement of Capacitance, Schering's bridge, Measurement of frequency, Wien's bridge. A-D and D-A Conversion: 4-bit binary weighted resistor type D-A conversion, circuit and working. Circuit of R-2R ladder. A-D conversion characteristics, successive approximation ADC.	12	9		1
III	Oscilloscopes: CRT, wave form display and electrostatic focusing, time base and sweep synchronization, measurement of voltage, frequency and phase by CRO, Oscilloscope probes, Dual trace oscilloscope. DSO and DPO: Basic idea, working principle, Advantages and applications. Signal Generators: Audio oscillator, Pulse Generator, Function generators.	10	13		
IV	Instrumentation Amplifier (IA): Introduction, need, application, and characteristics of instrumentation amplifier, Basic differential amplifier, 2-opamp and 3 op-amp IA, Design Considerations for IA.	8			
V	PRACTICAL 1. Design of multi range ammeter and voltmeter using galvanometer. 2. To measure voltage, frequency and phase of a electrical signal using CRO 3. Design of multi range ammeter and voltmeter using galvanometer.	20		30	

4. Measurement of resistance by Wheatstone bridge and measurement of bridge sensitivity. 5. Measurement of Self Inductance by Anderson Bridge. 6. Measurement of unknown inductance by Maxwell's Bridge 7. Designing of an amplifier of given gain for an inverting and non-inverting configuration using an opamp. 8. Design a Differential Amplifier 9. To design a 3-op-amp instrumentation amplifier and verify its gain equation 10. Measure CMRR of an Instrumentation Amplifier				
	42 + 20	60		5

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (18 Marks)

A. Sessional Tests (1+2):

Marks: 20+20

B. Sessional Activity

i. Surprise Test

10

ii. Attendance

10

iii. Assignment

10

iv. Seminar

10

In-semester Assessment:

Marks: 18

Textbooks

1. Helfrick, A. D. and Cooper, W. D. (2015 Reprint), *Modern Electronic Instrumentation and Measurement Techniques*, Prentice Hall of India (PHI Learning), New Delhi.
2. Bell, D. A. (2013), *Electronic Instrumentation and Measurements*, 2nd Edition, Oxford University Press, New Delhi.
3. Sawhney, A. K. and Sawhney, P. (2023), *A Course in Electrical and Electronic Measurements and Instrumentation*, 21st Edition, Dhanpat Rai & Co., New Delhi.

E-Learning Sources

1. **Electrical Measurements and Electronic Instruments**, NPTEL, IIT Kharagpur.
2. **Industrial Instrumentation**, NPTEL, IIT Kharagpur.
3. **Measurements and Instrumentation**, NPTEL, IIT Roorkee.
4. **Instrumentation and Measurement**, SWAYAM-NPTEL.
5. **Electronic Interfaces**, MIT OpenCourseWare, Massachusetts Institute of Technology.
6. **Virtual Electrical and Electronic Measurements Laboratory**, Virtual Labs, IIT

SEMESTER-IV

Course Title	: ELECTRONIC MATERIALS (A)
Course Code	: DSE-4-ELE-401 (A)
Nature of the Course	: MINOR (DSE-V)
Total Credit assigned	: 4
Components of the course	: L-4, P-0, T-0
Distribution of Marks	: End Semester: 56 In Semester: 24

Course Objectives

Unit	Contents	M	L	P	T
I	Crystalline structure: Single crystals - unit cells, Bravais lattices, crystal planes, Miller indices. X-ray diffraction; Lattice vibrations; properties of polycrystalline and amorphous materials, crystalline defects.	8	15		
II	Semiconductors: Classification of solids - insulator, semiconductor and conductors; Intrinsic and extrinsic Semiconductors, Compound semiconductors – binary, ternary and quaternary types and their properties. carrier generation and recombination. Electronic properties and application of semiconductor, semiconductor junction, metal – insulator junction, insulator – semiconductor junction in electronic device fabrication. Low-dimensional semiconductor structures: super lattice, quantum wells, wires and dots and their application in electronics; organic and polymer materials for electronics	11	16		
III	Conductors: Free electron theory of metals, Electrical conductivity and resistance. Boltzmann transport equation, thermionic emission and photoelectric effect, contact potential between metals, metallic alloys – interstitial and substitutional solid solutions, mutual solubility. Properties of common metals (Gold, Copper, Aluminum etc.) and their applications in fabrication of electrical components and electronic devices	12	14		
IV	Dielectrics: Dielectric polarizations - electronic, ionic, orientation types, dielectric breakdown Alternating field behavior of dielectrics, dielectric loss and relaxation time. Properties of dielectrics such as mica, ceramics, Silicon dioxide, Silicon Nitride etc., and their applications in fabrication of electrical components and electronic devices.	12		30	

V	Magnetic materials and Superconductors: Theory of ferromagnetic, anti-ferromagnetic, paramagnetic and diamagnetic materials. Properties and application in electrical and electronic engineering. Physics of superconductors and superconducting materials, Josephson effect, SQUID, High temperature superconductivity and its applications.	13	45		
		56	60		

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (24 Marks)

A. Sessional Tests (1+2):	Marks:	20+20
B. Sessional Activity		
i. Surprise Test		10
ii. Attendance		10
iii. Assignment		10

In-semester Assessment:	Marks 24
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Textbooks

1. Kasap, S. O. (2018), *Principles of Electronic Materials and Devices*, 4th Edition, McGraw-Hill Education, New York.
2. Streetman, B. G. and Banerjee, S. K. (2015), *Solid State Electronic Devices*, 7th Edition, Pearson Education, Noida.
3. Raghavan, V. (2015), *Materials Science and Engineering: A First Course*, 6th Edition, PHI Learning Pvt. Ltd., New Delhi.

E-Learning Sources

1. **Electronic Materials and Devices**, NPTEL.
2. **Materials Science and Engineering**, NPTEL, IIT Kanpur.
3. **Semiconductor Physics**, NPTEL, IIT Madras.
4. **Electronic, Optical and Magnetic Materials**, NPTEL.
5. **Introduction to Solid State Chemistry**, MIT OpenCourseWare, Massachusetts Institute of Technology.
6. **Materials Science and Engineering**, MIT OpenCourseWare, Massachusetts Institute of Technology.

SEMESTER-IV

Course Title	: INTERNET OF THINGS (B)
Course Code	: MIN-4-ELE-401 (B)
Nature of the Course	: MINOR (DSE-V)
Total Credit assigned	: 4
Components of the course	: L-4, P-0, T-0
Distribution of Marks	: End Semester: 56 In Semester: 24

Unit	Contents	M	L	P	T
I	Introduction: Fundamentals of IoT: Introduction, Definitions & Characteristics of IoT, IoT Architectures, Physical & Logical Design of IoT, Enabling Technologies in IoT, History of IoT, About Things in IoT, The Identifiers in IoT, About the Internet in IoT, IoT frameworks, IoT and M2M. IoT Sensing and Actuation: Introduction, Sensors, Sensor Characteristics, Sensorial Deviations, Sensing Types, Sensing Considerations, Actuators, Actuator Types, Actuator Characteristics.	14	16		
II	IoT Processing Topologies and Types: Data Format, Importance of Processing in IoT, Processing Topologies, IoT Device Design and Selection Considerations, Processing Offloading Wireless Technologies for IoT: WPAN Technologies for IoT: IEEE 802.15.4, Zigbee, HART, NFC, Z-Wave, BLE, Bacnet, Modbus. IP Based Protocols for IoT IPv6, 6LowPAN, RPL, REST, AMPQ, CoAP, MQTT. Edge connectivity and protocols	16	17		
III	CLOUD & EDGE COMPUTING FOR IOT: Cloud Platforms for IoT: AWS IoT, Google Cloud IoT, Microsoft Azure IoT Hub; Data Storage, Processing, and Visualization; Edge & Fog Computing Concepts; IoT Data Analytics and AI Integration	14	12		
IV	IOT CASE STUDIES AND FUTURE TRENDS Vehicular IoT, Healthcare IoT, Agricultural IoT, IoT Analytics	12	15	30	
		56	60		

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (24 Marks)

A. Sessional Tests (1+2):	Marks:	20+20
B. Sessional Activity		
i. Surprise Test		10
ii. Attendance		10
iii. Assignment		10

In-semester Assessment:

Marks 24

Textbooks

1. Bahga, A. and Madiseti, V. (2015), *Internet of Things: A Hands-On Approach*, Universities Press (India) Pvt. Ltd., Hyderabad.
2. Raj, P. and Raman, A. C. (2017), *The Internet of Things: Enabling Technologies, Platforms, and Use Cases*, CRC Press, Boca Raton.
3. Minoli, D. (2013), *Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications*, Wiley-IEEE Press, Hoboken.

E-Learning Sources

1. **Introduction to Internet of Things**, NPTEL, IIT Kharagpur.
2. **Internet of Things**, NPTEL, IIT Kharagpur.
3. **Introduction to Industry 4.0 and Industrial Internet of Things**, NPTEL, IIT Kharagpur.
4. **An Introduction to Programming the Internet of Things (IoT)**, University of California, Irvine, Coursera.
5. **Internet of Things (IoT)**, SWAYAM-NPTEL.
6. **IoT Virtual Laboratory**, Virtual Labs, Ministry of Education, Government of India.

SEMESTER-V

Course Title	: MICROPROCESSOR AND MICROCONTROLLER
Course Code	: MAJ-5-ELE-501
Nature of the Course	: MAJOR (DSC-VIII)
Total Credit assigned	: 5
Components of the Course	: L -4, P- 1, T -3
Distribution of Marks	: End Semester: 56 In Semester: 24 Practical:20

Course Contents:

Unit	Contents	M	L	P	T
I	Introduction to Microprocessor: Introduction, applications, basic block diagram, speed, word size, memory capacity, classification of microprocessors (mention different microprocessors being used) Microprocessor 8085: Features, architecture -block diagram, internal registers, register pairs, flags, stack pointer, program counter, types of buses. Multiplexed address and data bus, generation of control signals, pin description of microprocessor 8085.	13	15		1
II	8085 Instructions: Operation code, Operand & Mnemonics. Instruction set of 8085, instruction classification, addressing modes, instruction format. Data transfer instructions, arithmetic instructions, increment & decrement instructions, logical instructions, branch instructions and machine control instructions. Stack operations, subroutine calls and return operations. Delay loops, use of counters, timing diagrams-instruction cycle, machine cycle, T-states, time delay, Interrupt structure of 8085A microprocessor, processing of vectored and non-vectored interrupts, latency time and response time Interfacing of memory chips, Interfacing of I/O devices, LEDs and toggle-switches as examples, memory mapped and isolated I/O structure.	15	16		
III	Introduction to Microcontrollers: Basic block diagram, comparison of microcontroller with microprocessors, comparison of 8 bit, 16 bit and 32 bit microcontrollers. MICROCONTROLLER 8051: architecture -internal block diagram, key features of 8051, pin diagram, memory organization, Internal RAM memory, Internal ROM. General purpose data memory, special purpose/function registers, external memory, Instruction and addressing modes of 8051, Concept of stack, subroutine and related instructions, interrupts. Counters and timers: 8051 oscillator and clock, program counter, TCON, TMOD, timer counter interrupts, timer modes of operation. Input / output ports and circuits/ configurations, serial data input / output – SCON, PCON, serial data transmission modes. Timer / Counter Programming in 8051: Programming 8051 timers, counter programming, programming timers 0 and 1 in 8051 C	14	14		1

IV	PIC16F887 Microcontroller: Core features, Architecture, pin diagram, memory organization- Program and data memory organization, I/O Ports, oscillator module, Timer modules (Timer 0, Timer 1 and Timer 2), comparator module, analog-to-digital converter (ADC) module, data EEPROM, Enhanced capture/compare/PWM module, EUSART, master synchronous serial port (MSSP) module, special features of the CPU, interrupts, addressing modes, instruction set.	14	15		1
V	Microprocessor (8085) [Perform Any Five from below] 1. Program to transfer a block of data. 2. Program for multibyte addition 3. Program for multibyte subtraction 4. Program to multiply two 8-bit numbers. 5. Program to divide a 16-bit number by 8 bit number. 6. Program to search a given number in a given list. 7. Program to generate terms of Fibonacci series. 8. Program to sort numbers in ascending/descending order. 9. Program to find the square root of an integer. Microcontroller (8051) Programming [Perform Any three from below] 1. Program to find the sum of N 8-bit numbers. 2. Program to find largest of N numbers. 3. Program to find smallest of N numbers 4. Program to find whether the given data is palindrome. 5. Program to arrange the numbers in ascending order. Microcontroller (8051) Programming [Perform Any two from below] 6. Interfacing of stepper motor and Rotating stepper motor by N steps clockwise/ anticlockwise with speed control. 7. LCD interfacing. 8. Speed control of DC motor using PWM (pulse delay to be implemented using timers).	20		30	

Mode of In-Semester Assessment: (24 Marks)

A. Sessional Tests (1+2):	Marks:	20+20
B. Sessional Activity		
i. Surprise Test		10
ii. Attendance		10
iii. Assignment		10

In-semester Assessment:

Marks 24

Textbooks

1. Gaonkar, R. S. (2014), *Microprocessor Architecture, Programming and Applications with the 8085*, 6th Edition, Penram International Publishing (India) Pvt. Ltd., Mumbai.
2. Mazidi, M. A., Mazidi, J. G. and McKinlay, R. D. (2007), *The 8051 Microcontroller and Embedded Systems: Using Assembly and C*, 2nd Edition, Pearson Education, Noida.
3. Krishna Kant (2010), *Microprocessors and Microcontrollers: Architecture, Programming and System Design using 8085, 8086 and 8051*, PHI Learning Pvt. Ltd., New Delhi.
4. Ray, A. K. and Bhurchandi, K. M. (2019), *Advanced Microprocessors and Peripherals*, 3rd Edition, McGraw Hill Education (India) Pvt. Ltd., Noida.

E-Learning Sources

1. Microprocessors and Microcontrollers, NPTEL, IIT Kharagpur.
2. Microprocessors and Interfacing, NPTEL.
3. Embedded Systems Design, NPTEL, IIT Kharagpur.
4. Microprocessor to Microcontroller: Fundamentals of Embedded Systems, Coursera, University of Colorado Boulder.
5. Embedded Systems, NPTEL, IIT Madras.
6. Microprocessor and Microcontroller Virtual Lab, Virtual Labs, Ministry of Education, Government of India.

SEMESTER-V

Course Title : PROGRAMMING IN C AND C++

Course Code : MAJ-4-ELE-502

Nature of the Course : MAJOR (DSC-IX)

Total Credit assigned : 4

Components of the Course : L -3, P- 1, T -0

Distribution of Marks : End Semester: 42 In Semester: 18 Practical: 20

Course Contents

Unit	Contents	M	L	P	T
I	C Programming Language: Introduction of C, Character set, Tokens, Keywords, Identifier, Constants, Basic data types in C, Concept of variables, Structure of C program. Arithmetic operators, Relational operators, Logical operators, Assignment operators, Increment and decrement operators, Conditional operators, Bit wise operators. Expressions and evaluation of expressions, Precedence of operators, Arrays: Concepts, Declaration, accessing elements, Storing elements, Two-dimensional and multi-dimensional arrays. Data Structures: Classification, Basic Operations Stacks: Representation of stack in C using Array, Operations of stack, Application of stack, Infix, Postfix & Prefix Expressions, Postfix expression evaluation	12	13		2
II	Object Oriented Programming (OOP): Introduction, Object oriented programming, Characteristics of an object-oriented language, Basic concepts of object-oriented programming language (OOP), Applications of OOPs. C++ programming language: Basic structure of C++ program, Compiling and linking, Tokens, Data types, Arithmetic operators, Relational, Operators, Special operators, Expressions and evaluation of expressions, Scope Resolution operator, Dereferencing operator. Decision making and control loop structures: If statement, if... else statement, switch statement, do... While, while statement, for loop statement	13	14		1
III	Functions in C++: The main function, Function prototyping Call by reference Classes and objects: Defining member functions, Nesting of member functions, Function overloading, Memory allocation for objects, Static and dynamic allocation Pointer and polymorphism: Polymorphism, pointer to objects, Pointers to derived classes, Pointer to functions Managing console I/o operations: C++streams, Unformatted i/o operations, Structures: Declaration, Initialization, Nested of structure, Pointer to structures Inheritance: Extending classes, Derived classes	17	18		1

	Practical: 1. Write a C program to display your name, roll number, and department. 2. Demonstrate arithmetic, relational, logical, and bitwise operations in C. 3. Develop a C program to input marks of five subjects and calculate average using arrays. 4. Create a program to store and print a 2D matrix and perform matrix addition. 5. Program to calculate sum of elements in a 3D array. 6. Write a simple C++ program using cout, cin, and basic data types. 7. Develop C++ programs using <i>if</i>, <i>if...else</i>, <i>switch</i>, <i>for</i>, <i>while</i>, and <i>do...while</i> loops. 8. Program to demonstrate special operators and expressions in C++. 9. Compile and link a basic C++ program with user-defined functions. 10. Write a C++ program demonstrating function prototyping and call by reference. 11. Create a class with member functions and illustrate function overloading. 12. Demonstrate the use of pointers to objects and pointers to functions. 13. Implement stack using arrays and perform push, pop operations. 14. Write a program to convert infix expression to postfix and evaluate it. 15. Develop a C program to implement simple queue operations using arrays.	20		30	
		42+ 20	45		

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (18 Marks)

A. Sessional Tests (1+2):	Marks:	20+20
B. Sessional Activity		
i. Surprise Test		10
ii. Attendance		10
iii. Assignment		10

In-semester Assessment:

Marks 18

Textbooks

4. Balagurusamy, E. (2020), *Programming in ANSI C*, 8th Edition, McGraw Hill Education (India) Pvt. Ltd., Noida.
5. Balagurusamy, E. (2022), *Object Oriented Programming with C++*, 8th Edition, McGraw Hill Education (India) Pvt. Ltd., Noida.
6. Prata, S. (2014), *C Primer Plus*, 6th Edition, Addison-Wesley Professional, Boston.

E-Learning Sources

4. **Programming in C**, NPTEL, IIT Kharagpur.
5. **Introduction to Programming in C**, NPTEL, IIT Kanpur.
6. **Programming, Data Structures and Algorithms using C**, NPTEL, IIT Madras.
7. **Object Oriented Programming**, NPTEL, IIT Kharagpur.
8. **Introduction to C and C++**, MIT OpenCourseWare, Massachusetts Institute of Technology.
9. **C Programming Virtual Lab**, Virtual Labs, Ministry of Education, Government of India.

SEMESTER-V

Course Title	: POWER ELECTRONICS
Course Code	: MAJ-4-ELE-503
Nature of the Course	: MAJOR (DSC-X)
Total Credit assigned	: 4
Components of the Course	: L -3, P- 1, T -0
Distribution of Marks	: End Semester: 42 In Semester: 18 Practical: 20

Course Contents

Unit	Contents	M	L	P	T
I	Power Devices: Need for semiconductor power devices, Power diodes, Enhancement of reverse blocking capacity, Introduction to family of thyristors. Silicon Controlled Rectifier (SCR): structure, I-V characteristics, Turn-On and Turn-Off characteristics, ratings, Factors affecting the characteristics/ratings of SCR, Gate-triggering circuits, Control circuits design and Protection circuits, Snubber circuit.	12	12		
II	Diac and Triac: Basic structure, working and V-I characteristic of, application of a Diac as a triggering device for a Triac. Insulated Gate Bipolar Transistors (IGBT): Basic structure, I-V Characteristics, switching characteristics, device limitations and safe operating area (SOA) etc. Application of SCR: SCR as a static switch, phase-controlled rectification, single phase half wave, full wave and bridge rectifiers with inductive & non-inductive loads; AC voltage control using SCR and Triac as a switch. Power MOSFETs: operation modes, switching characteristics, power BJT, second breakdown, saturation and quasi-saturation state.	13	15		
III	Power Inverters: Need for commutating circuits and their various types, d.c. link invertors, Parallel capacitor commutated invertors with and without reactive feedback and its analysis, Series Invertor, limitations and its improved versions, bridge invertors. Choppers: basic chopper circuit, types of choppers (Type A-D), step-down chopper, step-up chopper, operation of d.c. chopper circuits using self commutation (A & B-type commutating circuit), cathode pulse turn-off chopper (using class D commutation), load sensitive cathode pulse turn-off chopper (Jones Chopper), Morgan's chopper	17	18		
IV	Practicals 1. Study of I-V characteristics of DIAC 2. Study of I-V characteristics of a TRIAC 3. Study of I-V characteristics of a SCR 4. SCR as a half wave and full wave rectifiers with R and RL loads	20		30	

5. DC motor control using SCR. 6. DC motor control using TRIAC. 7. AC voltage controller using TRIAC with UJT triggering. 8. Study of parallel and bridge inverter. 9. Design of snubber circuit 10. VI Characteristic of MOSFET and IGBT (Both) 11. Study of chopper circuits				
	42+ 20	45		

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (18 Marks)

A. Sessional Tests (1+2):	Marks:	20+20
B. Sessional Activity		
i. Surprise Test		10
ii. Attendance		10
iii. Assignment		10

In-semester Assessment:

Marks 18

Textbooks

1. Rashid, M. H. (2014), *Power Electronics: Circuits, Devices and Applications*, 4th Edition, Pearson Education, Noida.
2. Singh, M. D. and Khanchandani, K. B. (2017), *Power Electronics*, 2nd Edition, Tata McGraw-Hill Education, New Delhi.
3. Mohan, N., Undeland, T. M. and Robbins, W. P. (2003), *Power Electronics: Converters, Applications and Design*, 3rd Edition, John Wiley & Sons, New York.
4. Sen, P. C. (2009), *Power Electronics*, Tata McGraw-Hill Education, New Delhi.

E-Learning Sources

1. **Power Electronics**, NPTEL, IIT Kharagpur.
2. **Power Electronics**, NPTEL, IIT Delhi.
3. **Introduction to Power Electronics**, NPTEL, IIT Madras.
4. **Power Electronics and Drives**, NPTEL.
5. **Power Electronics**, MIT OpenCourseWare, Massachusetts Institute of Technology.
6. **Power Electronics Virtual Laboratory**, Virtual Labs, Ministry of Education, Government of India.

SEMESTER-V

Course Title : PHOTONICS (A)
 Course Code : MIN-3-ELE-501(A)
 Nature of the Course : MINOR (DSE-VI)
 Total Credit assigned : 3
 Components of the course : L-3, P-0, T-0
 Distribution of Marks : End Semester: 42 In Semester: 18

Unit	Contents	M	L	P	T
I	Light as an Electromagnetic Wave: Plane waves in homogeneous media, concept of spherical waves. Reflection and transmission at an interface, total internal reflection, Brewster's Law. Interaction of electromagnetic waves with dielectrics: origin of refractive index, dispersion. Interference: Superposition of waves of same frequency, Concept of coherence, Interference by division of wavefront, Young's double slit, Division of Amplitude, Newton's rings; Michelson interferometer. Holography. Diffraction: Huygen Fresnel Principle, Fresnel and Fraunhofer approximations. Fraunhofer Diffraction by a single slit, Resolving power of microscopes and telescopes; Diffraction grating: Resolving power and Dispersive power	18	20	0	1
II	Polarization: Linear, circular and elliptical polarization, polarizer-analyzer and Malus' law; Double refraction by crystals, Interference of polarized light, Half wave and quarter wave plates. Faraday rotation and electro-optic effect.	12	13	0	0
III	Light Emitting Diodes: LED Construction, materials and operation. Lasers: Interaction of radiation and matter, Einstein coefficients, Condition for amplification, laser cavity, threshold for laser oscillation, line shape function. Examples of common lasers. diode laser. Photodetectors: Photomultiplier tube, Photo transistors and Photodiodes (p-i-n, avalanche), quantum efficiency and responsivity. LCD Displays: Types of liquid crystals, Principle of Liquid Crystal Displays, its applications and advantages over LED displays.	12	13		
		42	45	0	1

Mode of In-Semester Assessment: (18 Marks)

A. Sessional Tests (1+2):	Marks:	20+20
B. Sessional Activity		
i. Surprise Test		10
ii. Attendance		10
iii. Assignment		10

In-semester Assessment:	Marks 18
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Textbooks

1. Ghatak, A. and Thyagarajan, K. (2012), *Introduction to Fiber Optics*, Cambridge University Press, New Delhi.
2. Saleh, B. E. A. and Teich, M. C. (2019), *Fundamentals of Photonics*, 3rd Edition, John Wiley & Sons, Hoboken.
3. Keiser, G. (2021), *Optical Fiber Communications*, 6th Edition, McGraw Hill Education, New York.

E-Learning Sources

1. **Fiber Optic Communication Technology**, NPTEL, IIT Kharagpur.
2. **Optical Communication**, NPTEL, IIT Delhi.
3. **Optoelectronic Materials and Devices**, NPTEL, IISc Bangalore.
4. **Photonics and Optoelectronics**, NPTEL.
5. **Optics**, MIT OpenCourseWare, Massachusetts Institute of Technology.

SEMESTER-V

Course Title	: BIOMEDICAL INSTRUMENTATION (B)
Course Code	: MIN-3-ELE-501(B)
Nature of the Course	: MINOR (DSE-VI)
Total Credit assigned	: 3
Components of the course	: L-3, P-0, T-0
Distribution of Marks	: End Semester: 42 In Semester: 18

Unit	Contents	M	L	P	T
I	Biomedical signals & Physiological transducers: Source of biomedical signal, Origin of bioelectric signals, recording electrodes, Electrodes for ECG, EMG & EEG; Physiological transducers: Pressure, Temperature, photoelectric & ultrasound Transducers. Respiratory system: Physiology of respiratory system, Measurement of breathing mechanics, Spiro meter, Respiratory therapy equipments: Inhalators, ventilators, Respirators, Humidifiers, Nebulizers, Aspirators, Biomedical recorders: ECG, EEG & EMG.	16	17		
II	Patient Monitoring systems: Cardiac monitor, Bedside patient monitor, measurement of heart rate, blood pressure, temperature, respiration rate, Arrhythmia monitor, Methods of monitoring fatal heart rate, Monitoring labor activity.	15	17		
III	Patients safety & Computer Applications in Biomedical field: Precaution, safety codes for electro medical equipment, Electric safety analyzer, Testing of biomedical equipment, Use of microprocessors in medical instruments, Microcontrollers, PC based medical instruments. Computerized Critical care units, Planning & designing a computerized critical care unit.	11	11		
		42	45		

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (18Marks)

A. Sessional Tests (1+2):	Marks:	20+20
B. Sessional Activity		
i. Surprise Test		10
ii. Attendance		10
iii. Assignment		10

In-semester Assessment:

Marks 18

Textbooks

1. Khandpur, R. S. (2014), *Handbook of Biomedical Instrumentation*, 3rd Edition, McGraw Hill

Education (India) Pvt. Ltd., Noida.

2. Cromwell, L., Weibell, F. J. and Pfeiffer, E. A. (2010), *Biomedical Instrumentation and Measurements*, 2nd Edition, Pearson Education, Noida.
3. Webster, J. G. and Eren, H. (2014), *Medical Instrumentation: Application and Design*, 4th Edition, John Wiley & Sons, Hoboken.

E-Learning Sources

1. **Biomedical Instrumentation**, NPTEL, IIT Madras.
2. **Biomedical Signal Processing**, NPTEL, IIT Kharagpur.
3. **Biomedical Engineering**, NPTEL.
4. **Introduction to Biomedical Engineering**, Duke University, Coursera.
5. **Health and Biomedical Informatics**, edX.
6. **Biomedical and Signal Processing Laboratory**, Virtual Labs, Ministry of Education, Government of India

SEMESTER-VI

Course Title	: Electronics Lab
Course Code	: MAJ-5-ELE-601
Nature of the Course	: MAJOR
Total Credit assigned	: 5
Components of the course	: L-0, P-5, T-0
Distribution of Marks	: End Semester: 100

A Student will have to perform at least 20 experiments (05 each from group A, B, C, and 05 from group D or E based on the opted DSE)

Unit	Contents	M	L	P	T
A	VLSI Circuits - To measure and analyze the current-voltage (I-V) characteristics of NMOS and PMOS transistors. - To determine the threshold voltage (V_{th}) of NMOS and PMOS transistors. - To analyze the voltage transfer characteristics (VTC) of a CMOS inverter. - To design and create the layout for basic CMOS gates (NAND, NOR, etc.). - To simulate the operation of CMOS logic gates - To design and analyze the performance of a CMOS NAND gate - To design and analyze the performance of a CMOS NOR gate. - To create the layout of a CMOS inverter and understand the physical design rules				
B	Electrical Machines - To determine the equivalent circuit parameters of a transformer. - To determine the efficiency and voltage regulation of a transformer under load. - To determine the performance characteristics of a DC shunt motor under varying load conditions. - To control the speed of a DC motor by varying the armature voltage. - To determine the parameters of the equivalent circuit of an induction motor - To determine the performance characteristics of an induction motor under different load conditions. - To study the operation and characteristics of a stepper motor - To understand microstepping and its effects on stepper motor performance.				
C	Sensors, Transducers and Actuators - Calibrate and test the performance of thermocouples, thermistors, and RTDs - Measurement of Linear Displacement Using LVDT - Measure strain in a material using strain gauges. - Pressure Measurement Using Piezoelectric Pressure Transducers				

	5 Measure light intensity using opto-electronic transducers. 6 Evaluate the performance of a hydraulic actuator system 7 Develop a mechatronic system that integrates multiple sensors and actuators				
D	Optoelectronics 1. To study the I-V characteristics and luminous intensity of a homo-junction LED. 2. To compare radiation patterns of surface-emitting and edge-emitting LEDs. 3. To calculate internal and external quantum efficiency of an LED from experimental data. 4. To study the spectral response and thermal effects on LED output. 5. To measure the modulation bandwidth of an LED using a square wave input. 6. To study the electroluminescent behavior of an OLED and its response to input voltage. 7. To demonstrate stimulated and spontaneous emission using a laser diode setup. 8. To study the threshold current and output power characteristics of a pn-junction laser diode. 9. To compare homo-junction and hetero-junction laser diode performance. 10. To measure the responsivity and dark current of a p-i-n photodiode. 11. To determine the response time and bandwidth of an avalanche photodiode. 12. To study the angular response and noise equivalent power of a photodetector. 13. To obtain the I-V characteristics and calculate the efficiency of a silicon-based solar cell under illumination.				
E	Robotics: Modeling of Robot Joints 1 Assembly of 2DOF/3DOF Robot Manipulator 2 Use of drives for robotic joints and its simulation 3 Roboanalyzer: A learning software of robotics study 4 Formulation of DH parameters of robot configuration 5 Simulation using open-source software of robot kinematics using DH Parameters 6 Forward kinematic analysis of a robot 7 Inverse kinematic analysis of a robot				
	End Sem	50+ 50			

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (30 Marks)

A. Continuous Evaluation

50

In-semester Assessment:

Marks 50

SEMESTER-VI

Course Title : INTRODUCTION TO VLSI CIRCUITS
Course Code : MAJ-4-ELE-602
Nature of the Course : MAJOR (DSC-XIII)
Total Credit assigned : 4
Components of the Course : L – 4, P-0, T - 3
Distribution of Marks : End Semester: 56 In Semester: 24

Course Contents:

Unit	Contents	M	L	P	T
I	Overview of VLSI and Logic Design with MOSFETs: Complexity and Design, Basic concepts, Ideal switches and Boolean operations, MOSFETs as switches, Basic logics gates in CMOS, Complex logic gates in CMOS, Transmission Gate circuits, Clocking and data flow control.	14	15		1
II	Physical Structure and Fabrication of CMOS ICs: Integrated Circuit layers, MOSFETs, CMOS layers, Designing FET arrays, Overview of silicon processing, Material growth and deposition, Lithography, The CMOS process flow, Design rules.	15	16		1
III	Elements of Physical Design and Electrical Characteristics of MOSFETs: Basic concepts, Layout of basic structures, Cell concepts, FET sizing and the unit transistor, Physical design of logic gates, Design hierarchies, MOS physics, nFET current-voltage equations, FET RC model, pFET characteristics, Modeling of small MOSFETs.	13	14		1
IV	Analysis of CMOS logic gates: DC characteristics of the CMOS inverter, Inverter switching characteristics, Power dissipation, DC characteristics: NAND and NOR gates, NAND and NOR transient response, Analysis of complex logic gates, Gate design for transient performance, Transmission gates and pass transistors. Designing High-speed CMOS Logic Networks: Gate delays, Driving Large capacitive loads, Logical effort, BiCMOS drivers.	14	15		
		56	60		3

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (24 Marks)

A. Sessional Tests (1+2):	Marks:	20+20
B. Sessional Activity		
i. Surprise Test		10
ii. Attendance		10
iii. Assignment		10
iv. Seminar		10

In-semester Assessment:

Marks 24

Books:

1. John P. Uyemura, "Introduction to VLSI circuits and Systems", John Wiley & Sons (Asia) Pte. Ltd., 2003.
2. S.K. Ghandhi, "VLSI Fabrication principles", 2/e, John Wiley & Sons (Asia) Pte. Ltd., 2003.
3. S.M. Sze, "VLSI Technology", 2/e, McGraw-Hill, 1988.
4. N.H.E. Weste and K. Eshraghian, "Principles of CMOS VLSI design", Pearson Education, Inc., 1999.
5. Yuan Taur and T.H. Ning, "Fundamentals of Modern VLSI devices", Cambridge University Press, 1998.
6. Principle of CMOS VLSI Design, a system perspective-Neil H.E. Weste and Kamran Eshraghian, Addison-wesley.
7. Weste, N. H. E. and Harris, D. M. (2015), *CMOS VLSI Design: A Circuits and Systems Perspective*, 4th Edition, Pearson Education, Noida.

E-Learning Sources

1. **Digital VLSI Design**, NPTEL, IIT Kharagpur.
2. **CMOS Digital VLSI Design**, NPTEL, IIT Madras.
3. **VLSI Design Flow: RTL to GDS**, NPTEL, IIT Kharagpur.
4. **Integrated Circuits, MOSFETs, Op-Amps and their Applications**, NPTEL, IIT Madras.
5. **VLSI System Design**, MIT OpenCourseWare, Massachusetts Institute of Technology.
6. **VLSI Design Virtual Lab**, Virtual Labs, Ministry of Education, Government of India.

SEMESTER-VI

Course Title	: ELECTRICAL MACHINES
Course Code	: MAJ-4-ELE-603
Nature of the Course	: MAJOR (DSE-XIV)
Total Credit assigned	: 4
Components of the course	: L-4, P-, T-0
Distribution of Marks	: End Semester: 56 In Semester: 24

Unit	Contents	M	L	P	T
I	Transformers: Types of transformers, Transformer Construction, EMF equation, No load operation, operation under load, Phasor diagram, equivalent circuit of transformer, Transformer Losses, Voltage regulation, condition for maximum efficiency, All day efficiency, Short circuit and open circuit tests Polyphase Circuits: Polyphase circuits, Three phase transformers, Star-delta, delta-delta and delta –Y connection	14	17		
II	DC Machines Construction, features and physical principles involved in electrical machine, armature winding (ac and dc), lap and wave connections, different types of pitches. DC Generators: Construction and principles of operation, brief idea about armature reaction and commutation, E.M.F. Equation, Methods of excitation, and Characteristics of Self excited and separately (Shunt, Compound and Series) excited generators, Losses and efficiency, applications. DC Motors: Comparison of generator and motor action & interchangeability, principle of operation, significance of back EMF, maximum power, Torque and speed relation, Characteristics of series, shunt and Compound excited motors, applications, losses & efficiency, necessity of motor starters, Three point starter, Speed control of DC motors, electronic speed control of DC motors.	16	17		
III	Polyphase Induction motors: Types of rotors, Rotating magnetic field (Ferrari's Principle), Production of torque, Torque equation, Slip, Torque-slip characteristics, Speed control of Induction motor. Comparison with DC motor Single Phase Motors: Single phase induction motors: Construction, principle of operation, starting methods: Split phase motors, capacitor start motors, capacitor start & run motors; Reluctance Motor, Stepper Motor, Single phase a.c. series motors, Universal motor.	14	11		
IV	Synchronous Machines: Brief construction details of three phase synchronous generators, E.M.F. equation, Principle of operation of synchronous motor, methods of starting, factors for failure to start, applications, comparison of synchronous and induction motor	12	15		

		56	60		
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(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (24 Marks)

A. Sessional Tests (1+2):	Marks:	20+20
B. Sessional Activity		
i. Surprise Test		10
ii. Attendance		10
iii. Assignment		10

In-semester Assessment:	Marks 24
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Textbooks

1. Nagrath, I. J. and Kothari, D. P. (2019), *Electrical Machines*, 5th Edition, McGraw Hill Education (India) Pvt. Ltd., Noida.
2. Fitzgerald, A. E., Kingsley, C. Jr. and Umans, S. D. (2013), *Electric Machinery*, 7th Edition, McGraw-Hill Education, New York.
3. Bimbhra, P. S. (2021), *Electrical Machinery*, 8th Edition, Khanna Publishers, New Delhi.

E-Learning Sources

1. **Electrical Machines – I**, NPTEL, IIT Kharagpur.
2. **Electrical Machines – II**, NPTEL, IIT Kharagpur.
3. **Electrical Machines**, NPTEL, IIT Madras.
4. **Electromechanical Energy Conversion**, NPTEL.
5. **Electric Machines**, MIT OpenCourseWare, Massachusetts Institute of Technology.
6. **Electrical Machines Virtual Laboratory**, Virtual Labs, Ministry of Education, Government of India.

SEMESTER-VI

Course Title : SENSORS, TRANSDUCERS AND ACTUATORS
Course Code : MAJ-4-ELE-604
Nature of the Course : MAJOR (DSC-XIV)
Total Credit assigned : 4
Components of the course : L-4, P-, T-0
Distribution of Marks : End Semester: 56 In Semester: 24

Unit	Contents	M	L	P	T
I	Review of transducer and Sensor, Role of a transducer in a generalized measurement system, Classification of transducers, Characteristics of transducers. Significant parameters of a transducer.	9	17		
II	Temperature sensors: Temperature scales, Mechanical temperature sensors, Resistance type temperature sensors, Platinum resistance thermometer, Thermocouples. Solid state sensors, Quartz thermometer, Radiation type sensors - Optical pyrometers, Calibration of thermometers Displacement and Strain Transducers: Displacement transducers - Variable resistance, inductance and capacitance. Linear voltage differential Transformer (LVDT) Strain -Definition, Principle of working of strain gauges, Gauge factor, Types of strain gauges, Materials for strain gauges. Pressure transducers: Manometers, Elastic transducers - Diaphragms, Bellows, Bourdon or helical tubes, Electrical pressure transducers - Variable resistance, inductance and capacitance. Piezoelectric pressure transducer. Opto-Electronic Transducers: Photoemission tube, Photomultiplier tube, Photoconductive cell, Photovoltaic cell (solar cell). Photodiode, Photo-transistor, Photo FET, Light emitting diode.	22	17		
III	Actuators: Definition, Classification of actuators: based on energy source (electrical, hydraulic, pneumatic) and motion (linear, rotary) Electrical Actuators: Solenoids (construction, working principle, applications), DC Motors: types (brushed, brushless), operation, Stepper Motors: types, step angle, applications, Servo Motors: working principle, applications Hydraulic Actuators: Basic principles of hydraulics, Components of hydraulic systems: pumps, valves, cylinders, Operation and control of hydraulic actuators, Advantages and disadvantages, typical applications	25	11		

	Pneumatic Actuators: Basic principles of pneumatics, Components of pneumatic systems: compressors, valves, actuators, Operation of pneumatic actuators, Advantages and disadvantages, typical applications				
		56	60		

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (24 Marks)

A. Sessional Tests (1+2):

Marks: 20+20

B. Sessional Activity

i. Surprise Test

10

ii. Attendance

10

iii. Assignment

10

In-semester Assessment:

Marks 24

Textbooks

1. Patranabis, D. (2017), *Sensors and Transducers*, 3rd Edition, PHI Learning Pvt. Ltd., New Delhi.
2. .
3. Bell, D. A. (2013), *Electronic Instrumentation and Measurements*, 2nd Edition, Oxford University Press.
4. Sawhney, A. K. and Sawhney, P. (2023), *A Course in Electrical and Electronic Measurements and Instrumentation*, 21st Edition, Dhanpat Rai & Co., New Delhi.

E-Learning Sources

1. Sensors and Actuators, NPTEL, IIT Kharagpur.
2. Industrial Instrumentation, NPTEL, IIT Kharagpur.
3. Measurement Systems and Instrumentation, NPTEL.
4. Introduction to Sensors, NPTEL.
5. Sensors and Sensor Circuit Design, Coursera, University of Colorado Boulder.
6. Sensors Modeling and Simulation Laboratory, Virtual Labs, Ministry of Education, Government of India.

SEMESTER-VI

Course Title	: OPTOELECTRONICS
Course Code	: MIN-3-ELE-601(A)
Nature of the Course	: MINOR (DSE-VII)
Total Credit assigned	: 3
Components of the course	: L-3, P-0, T-0
Distribution of Marks	: End Semester: 42 In Semester: 18

Unit	Contents	M	L	P	T
I	Light emitting diode (LED): LED materials, physics of homo-junction and hetero-junction LEDs, Radiation patterns of LED: surface and edge emitting diodes, LED characteristics: internal and external quantum efficiency, spectral width, thermal effects, modulation bandwidth. Basics of OLED and organic materials for OLED. Photodetectors: PD materials, pn junction PD, p-i-n PD, avalanche PD, PD characteristics- Dark current, responsivity, response times, electrical and optical bandwidth, angular response of PD, noise, noise equivalent power. Quantum limit, basics of photomultiplier tubes; Solar cells: I-V characteristics and spectral response, materials and fabrication of solar cells.	17	20		
II	Lasers: stimulated emission and spontaneous emission, population inversion, active medium, optical cavity and optical feedback, pn-junction laser diodes – homo-junction and hetero-junction lasers. Optical Fibres: Theory of dielectric waveguide, light coupling to fibers and propagation principle, Total internal reflection, fiber classifications based on mode and refractive index profile, Numerical aperture, acceptance angle, power loss inside the fibers, pulse dispersion, dispersion compensated fiber, fiber amplifier, fiber splicing.	15	15		
III	Luminescence: Luminescent materials: fluorescence & phosphorescence phenomena, Stokes shift, luminescent display devices based on CRT, LED, LCD	10	10		
		42	45		

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (18 Marks)

A. Sessional Tests (1+2):	Marks:	20+20
B. Sessional Activity		
i. Surprise Test		10
ii. Attendance		10
iii. Assignment		10

In-semester Assessment:	Marks 18
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Textbooks

1. Wilson, J. and Hawkes, J. F. B. (1998), *Optoelectronics: An Introduction*, 3rd Edition, Prentice Hall, London.
2. Bhattacharya, P. (2017), *Semiconductor Optoelectronic Devices*, 2nd Edition, Pearson Education, Noida.
3. Chuang, S. L. (2012), *Physics of Photonic Devices*, 2nd Edition, Wiley India Pvt. Ltd., New Delhi.

E-Learning Sources

1. **Optoelectronic Materials and Devices**, NPTEL, IISc Bangalore.
2. **Optical Communication**, NPTEL, IIT Delhi.
3. **Fiber Optic Communication Technology**, NPTEL, IIT Kharagpur.
4. **Photonics and Optoelectronics**, NPTEL.
5. **Optics**, MIT OpenCourseWare, Massachusetts Institute of Technology.
6. **Fiber Optics Virtual Lab**, Virtual Labs, Ministry of Education, Government of India.

SEMESTER-VI

Course Title	: (B) ROBOTICS
Course Code	: MIN-3-ELE-601(B)
Nature of the Course	: MINOR (DSE-VII)
Total Credit assigned	: 3
Components of the course	: L-3, P-0, T-0
Distribution of Marks	: End Semester: 42 In Semester: 18

Unit	Contents	M	L	P	T
I	Introduction to Robots: History of Robotics, Laws of Robotics, Terminologies and Basic Concepts, Applications of Robots, Current News in Robotics, Ethics in Robotics.	09	12		
II	Basic concepts of robotics: Kinematics: A four-link manipulator - A hands-on practice, Simulations hands-on in Robotics using RoboAnalyzer	07	9		
III	Introduction to Kinematics and Dynamics: Forward Kinematics, Inverse Kinematics, Jacobian Matrix, Concepts of Forward and Inverse Dynamics	14	14		
IV	Spatial Descriptions: Frames and Transformations: Coordinate System, Coordinate Transformation, Homogeneous Transformation Matrix, Denavit-Hartenberg Parameters	12	11		
		42	45		

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (18 Marks)

A. Sessional Tests (1+2):	Marks:	20+20
B. Sessional Activity		
i. Surprise Test		10
ii. Attendance		10
iii. Assignment		10

In-semester Assessment:	Marks 18
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Text Books:

1. Saha, Subit Kumar (2008), Introduction to Robotics, 2e, McGraw Hill Education (India).
2. Rupam Goswami, Ramana Vinjamuri and Nayan M. Kakoty (2024), Introduction to Embedded Systems and Robotics, Springer (Switzerland).

E-Learning Sources

1. Introduction to Robotics, NPTEL, Indian Institute of Science (IISc) Bangalore.
2. Robotics, NPTEL, Indian Institute of Science (IISc) Bangalore.
3. Introduction to Robotics, NPTEL, IIT Kharagpur.

4. Modern Robotics: Mechanics, Planning, and Control, Northwestern University, Coursera.
5. Underactuated Robotics, Massachusetts Institute of Technology (MIT OpenCourseWare).
6. Robotics Virtual Laboratory, Virtual Labs, Ministry of Education, Government of India.

North Lakhimpur University

SEMESTER-VII

Course Title : MICROWAVE AND ELECTROMAGNETICS
Course Code : MAJ-4-ELE-701
Nature of the Course : MAJOR
Total Credit assigned : 4
Components of the course : L-4, P-0, T- 0
Distribution of Marks : End Semester: 56 In Semester: 24

Unit	Contents	M	L	P	T
1	Limitations of conventional tubes: Limitations of conventional vacuum tubes at VHF and UHF; Bandwidth limitation effects, Tube reactance effects and transit time effects; Remedies. Klystron amplifier: Introduction to Klystron amplifier, Velocity modulation and bunching of electrons; L-cavity Klystron amplifier; operation and analysis; power and efficiency; Multi- cavity Klystrons, Reflex Klystrons, operation and analysis: Electronic admittance	15	17		0
2	Magnetron: Principle of Magnetron, Linear and cylindrical magnetron, Hull cut-off voltage and Hull cut off frequency, Basic principle of inverted magnetron.	10	10		
3	Fundamentals of electromagnetic theory: Formalism of Maxwell equations – differential & integral forms and their interpretations, boundary value problems based on Maxwell equations. Uniform plane waves: Uniform plane waves in time domain in free space, sinusoidal time-varying uniform plane waves in free space, wave equation and solution for material medium, uniform plane waves in Dielectrics and conductors, Poynting Vector.	12	15	0	0
4	Transmission lines-I (time domain analysis): TL equations and solutions, Determination of line parameters, line terminated by resistive load. Reactive and nonlinear resistive elements. Transmission lines-II (sinusoidal steady state analysis): Short circuited line, Line terminated by arbitrary load, TL line matching types, the smith chart and applications.	11	10	0	0
5	Metallic Waveguides and resonators: Uniform plane wave propagation in an arbitrary distinction, TE and TM waves in rectangular waveguide and cavity Resonator, Losses in Waveguides and Resonators.	8	8	0	1
		56	60	2	1

Mode of In-Semester Assessment: (24 Marks)**A. Sessional Tests (1+2):****Marks:****20+20****B. Sessional Activity****i. Surprise Test****10****ii. Attendance****10****iii. Assignment****10****iv. Seminar****10**

In-semester Assessment:**Marks 24****Textbooks**

1. Sadiku, M. N. O. (2018), *Elements of Electromagnetics*, 7th Edition, Oxford University Press, New Delhi.
2. Kulkarni, S. V. (2015), *Microwave and Radar Engineering*, 4th Edition, Umesh Publications, New Delhi.
3. Liao, S. Y. (2007), *Microwave Devices and Circuits*, 3rd Edition, Pearson Education, New Delhi.

E-Learning Sources

1. NPTEL Course: *Electromagnetic Fields*, IIT Madras.
2. NPTEL Course: *Electromagnetic Waves*, IIT Kharagpur.
3. NPTEL Course: *Microwave Engineering*, IIT Kharagpur.
4. NPTEL Course: *Microwave Integrated Circuits*, IIT Delhi.
5. MIT OpenCourseWare: *Electromagnetic Fields and Energy*.
6. MIT OpenCourseWare: *Microwave Circuits and Devices*.

SEMESTER-VII

Course Title	: ANALOG AND DIGITAL COMMUNICATION
Course Code	: MAJ-4-ELE-702
Nature of the Course	: MAJOR
Total Credit assigned	: 4
Components of the course	: L-3, P-1, T-3
Distribution of Marks	: End Semester: 42 In Semester: 18 Practical:20

Course Contents

Unit	Contents	M	L	P	T
I	Analog Communication: Elements of a communication system; Types of signals and communication channels; Need for modulation; Amplitude Modulation (AM) – generation, modulation index, spectrum and bandwidth; DSB-SC and SSB modulation; Frequency Modulation (FM) – generation, modulation index, spectrum and bandwidth; Demodulation of AM and FM signals; Noise in communication systems; Signal-to-noise ratio and performance of analog communication systems.	14	15		1
II	Digital Communication Fundamentals: Pulse modulation techniques: PAM, PWM and PPM; Sampling theorem; Pulse Code Modulation (PCM) – quantization, encoding and decoding; Delta Modulation (DM) and Adaptive Delta Modulation (ADM); Digital transmission of information; Baseband digital communication; Line coding techniques; Data rate and bandwidth requirements; Introduction to multiplexing techniques.	14	15		1
III	Digital Modulation and Communication Systems: Digital modulation techniques: ASK, FSK, PSK and QPSK; Bit error rate and noise performance; Digital communication receivers; Introduction to spread spectrum communication; Cellular communication concepts; Satellite communication systems; Optical fiber communication – basic principles, advantages and applications; Overview of modern digital communication systems and networks.	14	15		1
IV	PRACTICAL (Any 10) 1. Study the amplitude modulation (AM) waveform and determine the modulation index. 2. Generate and demodulate an AM signal using suitable modulation and detection circuits. 3. Study the frequency modulation (FM) waveform and determine the modulation parameters. 4. Generate and demodulate an FM signal. 5. Study Pulse Amplitude Modulation (PAM) and observe its waveform characteristics. 6. Study Pulse Width Modulation (PWM) and measure the variation in pulse width with the modulating signal. 7. Study Pulse Position Modulation (PPM) and observe its	20		30	

waveform characteristics. 8. Verify the Sampling Theorem using a signal generator and oscilloscope. 9. Study Pulse Code Modulation (PCM) encoding and decoding. 10. Study Delta Modulation (DM) and observe slope overload and granular noise effects. 11. Generate and study digital modulation schemes such as ASK, FSK and PSK. 12. Study line coding techniques and compare the waveforms of NRZ, RZ and Manchester coding. Simulation-Based Experiments (MATLAB/Scilab) 13. Simulation of AM and FM modulation and demodulation. 14. Simulation of PCM and Delta Modulation systems. 15. Simulation of ASK, FSK, BPSK and QPSK communication systems. 16. Measurement of Bit Error Rate (BER) for digital modulation schemes under noise.					
		42+ 20	45	30	3

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (18 Marks)

A. Sessional Tests (1+2):

Marks: 20+20

B. Sessional Activity

i. Seminar

10

ii. Assignment

10

iii. Attendance

10

In-semester Assessment:

Marks 18

Textbooks

1. Haykin, S. (2014), *Communication Systems*, 5th Edition, Wiley India Pvt. Ltd., New Delhi.
2. Lathi, B. P. and Ding, Z. (2010), *Modern Digital and Analog Communication Systems*, 4th Edition, Oxford University Press, New Delhi.
3. Sharma, S. K. (2017), *Analog and Digital Communication*, 3rd Edition, S. K. Kataria & Sons, New Delhi.

E-Learning Sources

1. NPTEL Course: *Analog Communication*, IIT Kanpur.
2. NPTEL Course: *Digital Communication*, IIT Kanpur.
3. NPTEL Course: *Principles of Communication Systems*, IIT Delhi.
4. SWAYAM-NPTEL: *Communication Engineering* courses.
5. MIT OpenCourseWare: *Principles of Digital Communication*.
6. NPTEL YouTube Channel: Communication Systems lecture series.

SEMESTER-VII

Course Title	: ADVANCED SEMICONDUCTOR DEVICES
Course Code	: MAJ-4-ELE-703
Nature of the Course	: MAJOR
Total Credit assigned	: 4
Components of the course	: L-3, P-1
Distribution of Marks	: End Semester: 42 In Semester: 18 Practical:20

Course Contents

Unit	Contents	M	L	P	T
I	Semiconductor Devices: Principle of operation, Fabrication methods and doping profiles, Analysis of the ideal diffusion transistor, Real transistors, Static I-V characteristics, Charge control equations, diffusion transistor at high frequencies, the drift transistor, high frequency performance Junction and MOS Field Effect Transistors: Principle of operation, Static I-V characteristics of the idealized model, JFET structures, Semiconductor surfaces, C-V characteristics of the MOS capacitor, the Si-SiO ₂ system, Basic structures and the operating principle of MOSFET, Current-Voltage characteristics	16	15		3
II	Power Semiconductor Devices: Shockley diode, Thyristor, Light Activated Silicon Controlled Rectifier (LACSR), Silicon Controlled Switch, GTO, IGBT, MCT, ETO, RCT, DIAC, TRIAC.	14	14		1
III	Optoelectronic Devices: Solar Cells, Photovoltaic effect, GaAs solar cells, Thin film solar cells, Photo detectors, Photo diode, Avalanche photo diode, LEDs, LED materials and their structures, Semiconductor Lasers – p-n junction laser, Hetero junction laser, Laser diode materials, fabrication and structures.	12	13		1
IV	PRACTICAL 1. Study of the I-V Characteristics of the CE configuration of BJT and obtain r_i, r_o, β 2. Study of the I-V Characteristics of the CB configuration of BJT and obtain r_i, r_o, α 3. Study of the I-V Characteristics of the CB configuration of BJT and obtain r_i, r_o 4. Study of the I-V Characteristics of JFET 5. Study of the I-V Characteristics of MOSFET 6. Study of the I-V Characteristics of Thyristor 7. Study of Characteristics of Solar Cell 8. Study of the I-V Characteristics of Photo diode 9. To determine characteristics of LEDs and Photo - Detector 10. Study of Hall effect	20		30	
		42 +	45	30	5

		20			
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(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (18 Marks)

A. Sessional Tests (1+2): **Marks:** **20+20**

B. Sessional Activity

i. Seminar **10**

ii. Assignment **10**

iii. Attendance **10**

In-semester Assessment: **Marks 18**

Textbooks

1. Sze, S. M. and Ng, K. K. (2007), *Physics of Semiconductor Devices*, 3rd Edition, John Wiley & Sons, Hoboken, New Jersey.
2. Sze, S. M. (2002), *Semiconductor Devices: Physics and Technology*, 2nd Edition, Wiley India Pvt. Ltd., New Delhi.
3. Streetman, B. G. and Banerjee, S. K. (2015), *Solid State Electronic Devices*, 7th Edition, Pearson Education, Noida.
4. M.S. Tyagi, "Introduction to Semiconductor Materials and Devices", John Wiley & Sons (Asia) Pte. Ltd., 2000

E-Learning Sources

1. NPTEL Course: *Semiconductor Devices*, IIT Bombay.
2. NPTEL Course: *Semiconductor Device Modeling*, IISc Bangalore.
3. NPTEL Course: *Optoelectronic Materials and Devices*, IISc Bangalore.
4. MIT OpenCourseWare: *Semiconductor Devices and Electronics*.
5. MIT OpenCourseWare: *Microelectronic Devices and Circuits*.
6. NPTEL YouTube Lectures on Semiconductor Devices, Power Semiconductor Devices and Optoelectronics.

SEMESTER-VII

Course Title	: (A) MACHINE LEARNING
Course Code	: DSE-4-ELE-701(A)
Nature of the Course	: Elective-I
Total Credit assigned	: 4
Components of the course	: L-4, P-0, T-0
Distribution of Marks	: End Semester: 56 In Semester: 24 Practical:20

Course Contents

Unit	Contents	M	L	P	T
I	Introduction to Statistics and Machine learning: Statistical Inference, Types of Variables, Probability Distribution, Normality, Measures of Central Tendencies, Normal Distribution, Fundamentals of Machine Learning, Concepts and types, KNN methods, Predictive Models	10	10		2
II	Classification and Regression: Random Forest, Decision tree, Linear Regression, Gradient Descent, Polynomial Regression, Learning Curves, Regularized Linear Models, Logistic Regression, Ridge Regression. Clustering, Partitioning Clustering, Hierarchical Clustering, Grid based clustering, Clustering algorithms, K-means algorithm, Applications of Clustering in different fields	12	15		1
III	Advanced Machine Learning concepts and techniques: Multilayer Perceptron's: Introduction Perceptron, Training a Perceptron: Learning Boolean Functions, Multilayer Perceptrons Back-propagation Learning: Supervised, unsupervised and reinforcement learning, types of unsupervised learning, KNN, regression models, Naive Bayes' classifier, decision trees, random forest classifier, SVM: linear, non-linear	18	20		1
IV	Introduction to Python: Python Basics, Variables and Data Types, Decision Making and Loops, Functions, Modules and Packages, Exception handling, File and Directories, Classes and objects, Regular expressions, Socket programming. Implementation of various ML algorithms using python	16	15		1
		56 + 20	60	30	8

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (24 Marks)

A. Sessional Tests (1+2):	Marks:	20+20
B. Sessional Activity		
i. Seminar		10
ii. Assignment		10
iii. Attendance		10

In-semester Assessment:	Marks 24
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Textbooks

1. Alpaydin, E. (2021), *Introduction to Machine Learning*, 4th Edition, MIT Press, Cambridge,

Massachusetts.

2. Mitchell, T. M. (1997), *Machine Learning*, McGraw-Hill Education, New York.
3. Burkov, A. (2019), *The Hundred-Page Machine Learning Book*, Andriy Burkov, Quebec, Canada.

E-Learning Sources

1. NPTEL Course: *Introduction to Machine Learning*, IIT Madras.
2. NPTEL Course: *Machine Learning*, IIT Kharagpur.
3. NPTEL Course: *Machine Learning for Engineering and Science Applications*, IIT Kharagpur.
4. SWAYAM-NPTEL: *Introduction to Machine Learning*.
5. Andrew Ng, *Machine Learning Specialization*, Stanford University and DeepLearning.AI, Coursera.
6. MIT OpenCourseWare: *Introduction to Machine Learning*.

SEMESTER-VII

Course Title : (B) INTRODUCTION TO IC DESIGN
Course Code : DSE-4-ELE-701(B)
Nature of the Course : ELECTIVE-I
Total Credit assigned : 4
Components of the course : L-4, P-0, T-0
Distribution of Marks : End Semester: 56 In Semester: 24

Course Contents

Unit	Contents	M	L	P	T
I	History and overview: History of Microelectronics, Components for logi, Integrated Circuit (IC) technology developments, Classification of IC. IC Design: IC design hierarchy, IC Technologies (CMOS, Bipolar, BiCMOS); CMOS Characteristics and Analysis: Review of MOS transistors, Characteristic and operation, MOS modes and regions of operations	10	12		2
II	Design Techniques: Static and dynamic logic design, Power consumption and speed considerations, Noise margins and signal integrity IC layout design: Stick diagram: Color code, Implied connection and crossover, Contacts and taps, Mask layout, Design rules and guidelines; Introduction to layout tools (e.g., Cadence, Mentor Graphics), nMOS layout, CMOS layout, Euler path, Multiple gates, Multiple-cell layout	14	15		1
III	Simulation and Design verification: Introduction to circuit simulation, AC, DC and transient analysis, CMOS component design procedures, Numerical integration, Convergence, Time step control, SPICE simulators Design Rule Check (DRC) and Layout Versus Schematic (LVS): Importance of DRC and LVS, Performing DRC and LVS checks, Interpreting DRC/LVS reports Testing methodologies: Fault modeling and fault simulation, Timing Analysis and Power Estimation: Static timing analysis, Power estimation techniques, Tools for timing and power analysis	18	18		1
IV	Fabrication and process technology: Semiconductor device fabrication process: Wafer preparation, Epitaxial growth, Oxidation, Photolithography, Diffusion, Ion implantation, Etching, Isolation, Metallization, Packaging	14	15		1
		56	60		5

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (24 Marks)

A. Sessional Tests (1+2):

Marks: 20+20

B. Sessional Activity

i. Seminar	10
ii. Assignment	10
iii. Attendance	10

In-semester Assessment:

Marks 24

Textbooks

1. Weste, N. H. E. and Harris, D. M. (2015), *CMOS VLSI Design: A Circuits and Systems Perspective*, 4th Edition, Pearson Education, Noida.
2. Kang, S. M. and Leblebici, Y. (2003), *CMOS Digital Integrated Circuits: Analysis and Design*, 3rd Edition, Tata McGraw-Hill Education, New Delhi.
3. Baker, R. J. (2019), *CMOS: Circuit Design, Layout and Simulation*, 4th Edition, Wiley-IEEE Press, Hoboken.

E-Learning Sources

1. NPTEL Course: *Digital VLSI Design*, IIT Kharagpur.
2. NPTEL Course: *CMOS Digital VLSI Design*, IIT Madras.
3. NPTEL Course: *VLSI Design Flow: RTL to GDS*, IIT Kharagpur.
4. NPTEL Course: *Analog IC Design*, IIT Madras.
5. SWAYAM-NPTEL: *VLSI Design*.
6. MIT OpenCourseWare: *VLSI System Design*.

SEMESTER-VII

Course Title : (C) MOBILE COMMUNICATION
Course Code : DSE-4-ELE-701(B)
Nature of the Course : ELECTIVE-I
Total Credit assigned : 4
Components of the course : L-4, P-0, T-0
Distribution of Marks : End Semester: 56 In Semester: 24

Course Contents

Unit	Contents	M	L	P	T
I	Cellular Communication Fundamentals: Introduction to mobile communication systems; Cellular concept and cell structure; Frequency reuse; Cell splitting and sectoring; Channel assignment; Handoff techniques; Interference, capacity and power control in cellular systems. Evolution of mobile communication systems: 1G, 2G, 3G, 4G and 5G.	12	14		2
II	Radio Wave Propagation and Mobile Channels: Propagation mechanisms: Reflection, diffraction and scattering; Path loss and shadowing; Multipath propagation and fading; Doppler effect; Delay spread, coherence bandwidth and coherence time; Flat and frequency-selective fading; Wireless channel characteristics.	11	13		1
III	Multiple Access and Modulation Techniques: Multiple access schemes: FDMA, TDMA, CDMA, SDMA and OFDMA; Digital modulation techniques: BPSK, QPSK, QAM and GMSK; Orthogonal Frequency Division Multiplexing (OFDM); Applications of OFDM in modern wireless communication systems	11	10		1
IV	MIMO and Mobile Communication Systems: Diversity techniques and receiver concepts; Introduction to MIMO systems; Spatial diversity and spatial multiplexing; Mobile antennas and antenna arrays; LTE and LTE-Advanced networks; Introduction to 5G architecture, enabling technologies and applications	11	12		1
V	Mobile Networks and Emerging Technologies: GSM architecture and services; GPRS and LTE data services; 5G network features and use cases; Internet of Things (IoT) in mobile networks; Performance measures: SNR, BER and outage probability; Emerging trends in wireless communication.	11	11		
		56	60		5

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (24 Marks)

A. Sessional Tests (1+2):	Marks:	20+20
B. Sessional Activity		
i. Seminar		10
ii. Assignment		10
iii. Attendance		10

Textbooks

1. Rappaport, T. S. (2002), *Wireless Communications: Principles and Practice*, 2nd Edition, Pearson Education, Noida.
2. Goldsmith, A. (2005), *Wireless Communications*, Cambridge University Press, Cambridge.
3. Garg, V. K. (2010), *Wireless Communications and Networking*, Morgan Kaufmann Publishers, Elsevier, Burlington.

E-Learning Sources

1. **Wireless Communication**, NPTEL, IIT Kanpur.
2. **Advanced Wireless Communication**, NPTEL, IIT Delhi.
3. **Wireless Ad Hoc and Sensor Networks**, NPTEL, IIT Kharagpur.
4. **Mobile Communication**, NPTEL Course Archive.
5. **Wireless Communications**, Massachusetts Institute of Technology (MIT OpenCourseWare).
6. **Introduction to 5G Technologies**, Coursera, Yonsei University.
7. .

SEMESTER-VII

Course Title	: OPERATIONAL AMPLIFIERS AND APPLICATIONS		
Course Code	: MIN-4-ELE-701		
Nature of the Course	: MAJOR		
Total Credit assigned	: 4		
Components of the course	: L-3, P-1, T-0		
Distribution of Marks	: End Semester: 42	In Semester: 18	Lab:20

Syllabus Contents

Unit	Contents	M	L	P	T
I	Basic Operational Amplifier: Concept of differential amplifiers (Dual input balanced and unbalanced output), constant current bias, current mirror, block diagram of an operational amplifier (IC 741) Op-Amp parameters: input offset voltage, input offset current, input bias current, differential input resistance, input capacitance, offset voltage adjustment range, input voltage range, common mode rejection ratio, slew rate, supply voltage rejection ratio.	10	11		
II	Op-Amp Circuits: Open and closed loop configuration, Frequency response of an op-amp in open loop and closed loop configurations; Inverting, Non-inverting, Summing and difference amplifier; Integrator, Differentiator, Voltage to current converter, Current to voltage converter; Comparators: Basic comparator, Level detector, Voltage limiters, Schmitt Trigger; Signal generators: Phase shift oscillator, Wein bridge oscillator, Square wave generator, triangle wave generator, Saw tooth wave generator, Voltage controlled oscillator	14	15		
III	Multivibrators (IC 555): Block diagram, Astable and monostable multivibrator circuit, Applications of Monostable and Astable multivibrators, Phase locked loops (PLL): Block diagram, phase detectors	10	11		2
IV	Signal Conditioning circuits: Sample and hold systems Active filters: First order low pass and high pass butterworth filter, Second order filters, Band pass filter, Band reject filter.	8	9		
V	List of practical 1. Design and Analysis of an Inverting Amplifier using IC 741. 2. Design and Analysis of a Non-Inverting Amplifier using IC 741. 3. Realization of a Summing Amplifier and Verification of Weighted Addition. 4. Design and Testing of a Differential (Difference) Amplifier. 5. Implementation of an Op-Amp Integrator and Study of its Response.	20			

6. Implementation of an Op-Amp Differentiator and Study of its				
7. Design of a Voltage-to-Current (V–I) Converter.				
8. Design of a Current-to-Voltage (I–V) Converter.Response.				
9. Design and Testing of a Schmitt Trigger Circuit.				
10. Design and Testing of a Zero-Crossing Detector using Op-Amp Comparator.				
11. Construction and Testing of IC 555 Astable Multivibrator.				
12. Construction and Testing of IC 555 Monostable Multivibrator.				
13. Applications of IC 555 Astable Multivibrator (LED Flasher/Pulse Generator).				
14. Design and Frequency Response Analysis of First-Order Active Low-Pass Butterworth Filter.				
15. Design and Frequency Response Analysis of First-Order Active High-Pass Butterworth Filter.				
	42	45		

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (24 Marks)

A. Sessional Tests (1+2):

Marks: 20+20

B. Sessional Activity

i. Surprise Test

10

ii. Attendance

10

iii. Assignment

10

iv. Seminar

10

In-semester Assessment:

Marks 18

Textbooks

1. Gayakwad, R. A. (2015), *Op-Amps and Linear Integrated Circuits*, 4th Edition, Pearson Education India, Noida.
2. Roy Choudhury, D. and Jain, S. (2018), *Linear Integrated Circuits*, 5th Edition, New Age International Publishers, New Delhi.
3. Coughlin, R. F. and Driscoll, F. F. (2001), *Operational Amplifiers and Linear Integrated Circuits*, 6th Edition, Prentice Hall of India, New Delhi

E-Learning Sources

1. **Integrated Circuits, MOSFETs, Op-Amps and their Applications**, NPTEL, IIT Madras.
2. **Circuits and Electronics (6.002x)**, MIT OpenCourseWare, Massachusetts Institute of Technology.
3. **Operational Amplifiers (Precision Labs Series)**, Texas Instruments.
4. **Operational Amplifier Applications**, Analog Devices Education Library.
5. **Linear Integrated Circuits and Applications**, NPTEL Course Repository.

SEMESTER-VIII

Course Title	: Indian Scientific Traditions and Electronics
Course Code	: MAJ-4-ELE-801
Total Credit assigned	: 4
Components of the course	: T:4
Distribution of Marks	: End Semester: 56 In Semester: 24

Course Contents:

Unit	Contents	M	L	P	T
I	Introduction to Indian Knowledge Systems: Concept, meaning, scope and significance of Indian Knowledge Systems; Sources of Indian knowledge including Vedas, Vedāṅgas, Upavedas, Itihāsa, Purāṇas and Śāstras; Methods of knowledge acquisition (Pramāṇas); Ancient centres of learning; Scientific and technological traditions in India; Relevance of IKS to contemporary science, technology and engineering.	10	11		
II	Mathematics and Computational Thinking in India: Development of the Indian numeral system; Decimal place-value system and concept of zero; Contributions of Aryabhata, Brahmagupta, Bhāskara and Mādhava; Algebraic and geometric traditions; Fundamentals of Vedic Mathematics; Combinatorics and algorithmic thinking; Pingala's Chandashastra and binary representation; Relevance to modern computation and digital technologies.	14	14		
III	Metrology – Measurements and Units in Ancient India: Concepts of measurement and standardization in ancient India; traditional units of length, area, volume, mass and time; measurement systems in Arthashastra and other classical texts; surveying and land measurement practices; precision, accuracy and calibration in traditional measurement systems; evolution of measurement standards and their relation to modern metrology.	12	10		
IV	Acoustics, Nāda, Music and Signal Concepts: Fundamentals of sound and acoustics; concept of Nāda, Ahata and Anahata Nāda; Shruti, Swara, Laya and Tala; frequency relationships and harmonics in Indian music; acoustical principles of traditional musical instruments; resonance and sound production; psychoacoustics; relevance of Indian musical concepts to modern audio systems, signal analysis and communication technologies.	10	12		
V	Materials, Metallurgy and Indigenous Technologies: Metallurgical achievements in ancient India; iron and steel technologies; zinc extraction and alloy development; corrosion resistance and the Iron Pillar of Delhi; indigenous engineering and manufacturing practices; traditional technologies for sustainable	10	13		

	resource utilization; relevance of traditional materials and technologies to modern materials science and engineering.				
		56+ 24	60	0	

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (24 Marks)

A. Sessional Tests (1+2): **Marks: 20+20**

B. Sessional Activity

i. Seminar **10**

ii. Assignment **10**

iii. Attendance **10**

In-semester Assessment: Marks 24

References:

Textbook

1. Mahadevan, B., Bhat, Vinayak Rajat & Pavana, Nagendra R. N. (2022). *Introduction to Indian Knowledge System: Concepts and Applications*. PHI Learning Private Limited, New Delhi.
2. Bora, M. C. (2024), *Foundations of Bharatiya Knowledge System*, Aayu Publications, Guwahati.
3. Balakrishnan, U., Joshi, R., and Gupta, M. D. (2024), *Indian Knowledge Systems*, McGraw Hill Education (India) Pvt. Ltd., Noida.
4. Kapur, K. N. and Singh, A. K. (2021), *Indian Knowledge Systems and Heritage*, D.K. Printworld, New Delhi.

Online Courses

5. *Indian Knowledge System – Concepts and Applications in Science and Management* (SWAYAM–IIM Bangalore). Available at:
[SWAYAM Course Portal https://onlinecourses.swayam2.ac.in/e-learning/preview/imb24_mg78](https://onlinecourses.swayam2.ac.in/e-learning/preview/imb24_mg78)

Video Lectures

6. *Indian Knowledge Systems Lecture Series* (YouTube). Available at:
<https://www.youtube.com/watch?v=AMIJhGFUZRw>
7. *Indian Knowledge Systems Lecture Series* (YouTube). Available at:
<https://www.youtube.com/watch?v=d45hBQ8Xw-c>
8. *Indian Knowledge Systems – Video Lecture Playlist* (YouTube). Available at:
https://www.youtube.com/playlist?list=PLRfu94TCePTtLuEYSzmJXNYK_EnDSvY3N

SEMESTER-VIII

Course Title : RESEARCH METHODOLOGY
Course Code : RM-4-ELE-802
Total Credit assigned : 4
Components of the course : T:4
Distribution of Marks : End Semester: 56 In Semester: 24

Course Contents:

Unit	Contents	M	L	P	T
I	Introduction to Research: Concept and characteristics of research; objectives and applications of research; types of research—basic research, applied research, action research, experimental research, and interdisciplinary research; research objectives and research questions; research problem—meaning, identification, and sources; research hypothesis; literature review and effective literature survey approaches. Research Design: Concept and importance of research design; features of a good research design; exploratory, descriptive, and experimental research designs; reliability and validity in research.	12	14		
II	Data Collection: Types and sources of data; methods of data collection; sampling concepts and sampling methods; characteristics of a good sample; probability and non-probability sampling techniques including simple random sampling, purposive sampling, convenience sampling, and snowball sampling. Data Presentation and Descriptive Analysis: Classification and organization of data; frequency distributions; graphical representation of data using histograms, frequency polygons, dot plots, stem-and-leaf plots, bar graphs, pie charts, scatter plots, and box plots; measures of central tendency; measures of dispersion; measures of relative standing; skewness and kurtosis.	13	14		
III	Scientific Writing: Principles of scientific writing; research reports and their structure; journal articles and their components; preparation of abstracts and keywords; theses and dissertations and their components; referencing styles, citations, bibliography, and reference management. Project Proposal: Components of a research proposal—title, abstract, introduction and rationale, objectives, methodology, work plan and timeline, budget and justification, expected outcomes, and references.	13	10		
IV	Intellectual Property Rights: Concept and significance of	10	12		

	intellectual property rights; patents, copyrights, trademarks, industrial designs, and geographical indications; patent rights and scope of protection; patenting and development process; Patent Cooperation Treaty (PCT) procedure; administration of patent systems; patent information and databases; technology licensing and commercialization.				
V	Research Ethics: Principles of research ethics; ethical review committees/Institutional Review Boards (IRB); responsible conduct of research; citation and acknowledgement; plagiarism. authorship and publication ethics.	8	10		
		56+ 24	60	0	

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (24 Marks)

A. Sessional Tests (1+2):

Marks: 20+20

B. Sessional Activity

i. Seminar

10

ii. Assignment

10

iii. Attendance

10

In-semester Assessment:

Marks 24

Textbooks

1. Kothari, C. R. and Garg, G. (2019), *Research Methodology: Methods and Techniques*, 4th Edition, New Age International Publishers, New Delhi.
2. Kumar, R. (2019), *Research Methodology: A Step-by-Step Guide for Beginners*, 5th Edition, SAGE Publications India Pvt. Ltd., New Delhi.
3. Creswell, J. W. and Creswell, J. D. (2018), *Research Design: Qualitative, Quantitative and Mixed Methods Approaches*, 5th Edition, SAGE Publications, Thousand Oaks, California.

E-Learning Sources

1. **Research Methodology**, NPTEL, Prof. Dipankar Deb, IIT Kharagpur.
2. **Research Methodology**, SWAYAM-NPTEL.
3. **Research Methods**, Open University (OpenLearn).
4. **Research Design and Methods**, SAGE Research Methods Video Collection.
5. **Introduction to Research**, SWAYAM MOOCs.

SEMESTER-VIII

Course Title : INTRODUCTION TO CMOS CIRCUITS
Course Code : MAJ-4-ELE-803
Nature of the Course : *CORE-IV [Honours]
Total Credit assigned : 4
Components of the course : L-4, P-0, T-0
Distribution of Marks : End Semester: 56 In Semester: 24 PRACTICAL: 00
Course Contents

Unit	Contents	M	L	P	T
I	Review of MOS device, discrete biasing of MOS amplifier, small signal analysis of amplifier in CS, CG & CD configurations; Multistage amplifiers, cascade and cascode amplifiers, effect of feedback in amplifier, frequency response, stability and noise, oscillators	8	10		
II	Different types of Current mirrors, their design and analysis, bandgap references, MOS amplifiers with active load; Design and analysis of MOS differential amplifier, two and three stage MOS Operational amplifiers, frequency compensation, non-ideal characteristics of operational amplifier.	14	15		
III	Sample and hold circuit, data converters (ADC, DAC), switch capacitor filters, Phase Lock Loop (PLL). MOS layout and fabrication, MOS scaling theory, recent advances in MOS transistors, SPICE model of MOS transistors and simulation	10	12		
IV	Review of logic families, TTL versus CMOS logic, Transient and static behavior of MOS device, design and analysis of logic gates in CMOS, pseudo n-MOS, BiCMOS logic, Power dissipation	10	8		
V	Clocked and dynamic CMOS, tristate circuits, transmission gates, dual rail logic, design and analysis of combinational & Sequential logic circuits and arithmetic circuits	14	15		
		56	60		

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (24 Marks)

A. Sessional Tests (1+2):	Marks:	20+20
B. Sessional Activity		
i. Attendance		10
ii. Assignment		10
iii. Seminar		10

In-semester Assessment:

Marks 24

Textbooks

1. Weste, N. H. E. and Harris, D. M. (2015), *CMOS VLSI Design: A Circuits and Systems Perspective*, 4th Edition, Pearson Education, Noida.

2. Kang, S. M. and Leblebici, Y. (2003), *CMOS Digital Integrated Circuits: Analysis and Design*, 3rd Edition, Tata McGraw-Hill Education, New Delhi.
3. Baker, R. J. (2019), *CMOS: Circuit Design, Layout and Simulation*, 4th Edition, Wiley-IEEE Press, Hoboken.

E-Learning Sources

1. **CMOS Digital VLSI Design**, NPTEL, IIT Madras.
2. **Digital VLSI Design**, NPTEL, IIT Kharagpur.
3. **VLSI Design Flow: RTL to GDS**, NPTEL, IIT Kharagpur.
4. **Integrated Circuits, MOSFETs, Op-Amps and their Applications**, NPTEL, IIT Madras.
5. **VLSI System Design**, MIT OpenCourseWare, Massachusetts Institute of Technology.
6. **CMOS VLSI Design**, NPTEL Video Courses and SWAYAM-NPTEL Archive.

SEMESTER-VIII

Course Title : CONTROL SYSTEMS
Course Code : MAJ-4-ELE-804
Nature of the Course : *CORE-IV [Honours]
Total Credit assigned : 4
Components of the course : L-4, P-0, T-0
Distribution of Marks : End Semester: 56 In Semester: 24 PRACTICAL: 00
Course Contents

Unit	Contents	M	L	P	T
I	Introduction and system representation Concept of control system; Classification of control systems—Open-loop and Closed-loop systems; Effects of feedback; Mathematical modelling of electrical and mechanical systems; Transfer function representation; Block diagram algebra; Signal Flow Graphs (SFG) and Mason's Gain Formula; Pole-zero concept.	10	11		
II	Time Response Analysis Standard test signals; Time response of first-order and second-order systems; Time-domain specifications—delay time, rise time, peak time, maximum overshoot, settling time and steady-state error; Static error constants; Effect of controller gain on system response; Introduction to P, PI and PID controllers.	12	15		
III	Stability Analysis and Root Locus Concept of stability; Necessary and sufficient conditions for stability; Routh–Hurwitz stability criterion; Relative stability; Root locus technique; Construction of root loci; Effect of gain variation on system performance; Introduction to state-space representation.	11	12		
IV	Frequency Response Analysis Frequency response of control systems; Polar plots; Bode plots; Gain margin and phase margin; Nyquist stability criterion; Nyquist plots and stability analysis; Correlation between time-domain and frequency-domain specifications.	11	11		
V	Control System Design Design specifications and performance measures; Lead, lag and lead-lag compensators; PID controllers and their applications; Design using root locus and frequency response techniques; Introduction to computer-aided control system analysis and design using MATLAB/Scilab; Applications of control systems in industrial automation, robotics and electronic systems.	12	11		
		56	60		

(L= Lecture, P = Practical, T = Tutorial)

Mode of In-Semester Assessment: (24 Marks)

A. Sessional Tests (1+2):

Marks:

20+20

B. Sessional Activity

i. Attendance	10
ii. Assignment	10
iii. Seminar	10

In-semester Assessment:

Marks 24

Textbooks

1. Nagrath, I. J. and Gopal, M. (2017), *Control Systems Engineering*, 7th Edition, New Age International Publishers, New Delhi.
2. Kuo, B. C. and Golnaraghi, F. (2017), *Automatic Control Systems*, 10th Edition, McGraw-Hill Education, New York.
3. Ogata, K. (2010), *Modern Control Engineering*, 5th Edition, Prentice Hall, Upper Saddle River, New Jersey.

E-Learning Sources

1. **Control Engineering**, NPTEL, IIT Kharagpur.
2. **Control Systems**, NPTEL, IIT Madras.
3. **Modern Control System Design**, NPTEL, IIT Madras.
4. **Feedback Control Systems**, NPTEL, IIT Roorkee.
5. **Control of Mobile Robots**, Coursera, Georgia Institute of Technology.
6. **Control Systems**, MIT OpenCourseWare, Massachusetts Institute of Technology.

SEMESTER-VIII

Course Title	:	PROJECT WORK
Course Code	:	MAJ-4-ELE-805
Nature of the Course	:	*CORE-805 [Honours]
Total Credit assigned	:	4
Components of the Course	:	L-0, T – 0, P-4
Distribution of Marks	:	PRACTICAL-80

Course Contents

Unit	Contents	M	L	P	T
I	PROJECT: The project is an essential component of the UG programme in Electronics. The project involves both the application of skills learned in the past and the acquisition of new skills. It allows the students to demonstrate their ability to organize and carry out a major piece of work according to sound scientific and engineering principles. The types of activity involved in each project will vary but all will typically share the following features: 1. Research the literature and gather background information 2. Analyze the requirements, compare alternatives and specify a solution 3. Design and implement the solution 4. Experiment and evaluate the solution 5. Develop written and oral presentation skills			80	
				80	

(L: Lecture T: Tutorial P: Practical)

SEMESTER-IV

Course Title	:	DISSERTATION WORK
Course Code	:	MAJ-12-ELE-803
Nature of the Course	:	**CORE-803 [Honours with Research]
Total Credit assigned	:	12
Components of the Course	:	L-0, T – 0, P-12
Distribution of Marks	:	PRACTICAL-240

Course Contents

Unit	Contents	M	L	P	T
I	The Dissertation is a major research component of the B.Sc. Electronics (Honours with Research) programme. It is intended to provide students with exposure to independent research and advanced investigation in Electronics and allied areas. The work shall involve the application of scientific methods to address a research problem and may include theoretical, experimental, computational, simulation-based, or interdisciplinary studies. The dissertation shall be undertaken under the guidance of a faculty supervisor. Students are expected to demonstrate originality, analytical ability, critical thinking, scientific writing skills, and competence in conducting independent research. The activities involved in the dissertation shall typically include: 1. Identification and formulation of a research problem. 2. Comprehensive literature review using journals, books, patents, and technical databases. 3. Development of research objectives and methodology. 4. Design and execution of experiments, simulations, modelling, or prototype development. 5. Collection, processing, and analysis of data. 6. Interpretation and discussion of results. 7. Preparation of a dissertation following standard scientific format. 8. Seminar presentation, dissertation defense, and viva-voce. Suggested Research Areas • Semiconductor Devices and VLSI • Embedded and Intelligent Systems • Internet of Things and Smart Systems			120	

	• Signal and Image Processing • Communication and Networking • Artificial Intelligence Applications in Electronics • Sensors and Instrumentation • Renewable Energy Systems • Robotics and Automation • Interdisciplinary Electronics Research				

(L: Lecture T: Tutorial P: Practical)

Suggested Evaluation Scheme for Honours with Research (240 Marks)

Component	Marks
Problem Identification	30
Research Proposal and Literature Review	40
Research Work and Results	80
Dissertation Report	40
Seminar Presentation and Viva-Voce	50
Total	240