Course Structure of M. Sc. (Electronics)

Semester I (Core and Foundation and Generic Elective Courses)				
Course	**Course Title**	**Teaching time/week**	**Marks**	Credits
ELET-111	Electronics System	4 hours	100	4
ELET-112	Industrial Power Electronics	4 hours	100	4
ELET-113	Embedded Systems -I	4 hours	100	4
ELET-114	Generic Elective – I i. 8086 Microprocessor and Interfacing ii. Optoelectronics	4 hours	100	4
ELET-115	Research Methodology	1 hours	30	1
COM-100	***Constitution of India***	***2 hours***	***50***	***2***
ELEL- 121	Lab course 1 (based on ELET-111 and ELET-112)	6 hours	50	3
ELEL- 122	Lab course 2 (based on ELET-113 and ELET-114)	6 hours	50	3
ELER-131	Review of literature and Formulation of Topic for Research Project / Industry Project / Product Development	6 hours	50	3
Total Credits for Semester I : 28 (Theory : 19 ; Laboratory : 06, Research Projects : 03)				
Semester II (Core, Foundation and Generic Elective Courses)				
ELET -211	Embedded System –II (PIC Microcontroller)	4 hours	100	4
ELET -212	Microcontroller Interfacing	4 hours	100	4
ELET -213	Generic Elective – II i. Sensors and Actuators ii. Industrial Robotics iii. Signal Conditioning Circuits	4 hours	100	4
ELET -214	Generic Elective – III i. Advanced Sensor Technology ii. Industrial Processes and Instrumentation iii. Biomedical Instrumentation	4 hours	100	4
ELEL -221	Lab course 3	6 hours	50	3

	(based on ELET-211, ELET-212, ELET-213 and ELET-214)			
ELER -231	Research Project / Industry Project / Product Development Part I (Experimental Work)	12 hours	100	6
Total Credits for Semester II : 25 (Theory : 16 ; Laboratory : 03 ; Research Project : 06)				
Semester III (Foundation and Generic Elective Courses)				
ELET -311	Programmable Logic Controllers	4 hours	100	4
ELET -312	ARM Microcontroller	4 hours	100	4
ELET -313	Generic Elective – IV i. Computational Modeling and Simulation ii. Applied Hydraulics and Pneumatics iii. PC Based Instrumentation iv. VLSI Design, Tools and Technology	4 hours	100	4
ELET -314	Generic Elective – V i. Characterization Tools in Sensors ii. Industrial Networking iii. Kinetics and Dynamics of Robotics iv. Smart Fusion Technology based System Design	4 hours	100	4
ELEL -321	Lab course 4 (based on ELET-311, ELET-312, ELET-313 and ELET-314)	6 hours	50	3
ELER -331	Research Project / Industry Project / Product Development Part II (Experimental Work)	18 hours	100	9
Total Credits for Semester III : 28 (Theory : 16 ;Laboratory : 03 ; Research Project : 09)				
Semester IV (Foundation, Generic and Open Elective Courses)				
ELET -411	Communication Technology	4 hours	100	4
ELET -412	Internet of Things (IoT)	4 hours	100	4
ELET -413	Generic Elective – VI i. Device Fabrication Technology ii. Flexible ManufacturingTechnology iii. Mixed Signal SoC Design iv. HMI, SCADA basics and Databases	4 hours	100	4
OELE-101	Open Elective (from other Departments)	4 hours	100	4

ELEL -421	Lab course 5 (based on ELET-411, ELET-412 and ELET-413)	6 hours	50	3
ELER -431	Research Project / Industry Project / Product Development Part III (Organization and Interpretation of Results)	8 hours	100	4
ELER -432	Research Project / Industry Project / Product Development Part IV (Dissertation and Presentation)	4 hours	50	2
Total Credits for Semester IV : 25 (Theory : 16 ;Laboratory : 03 ; Research Project : 06)				
Total Credits : 106 (Sem I : 28 + Sem II : 25 : Sem III : 28 + Sem IV : 25)				

Details of Teaching Work Load for M. Sc. Electronics

Semester I			
Theory			
Type of Courses	Number of Courses	Contact Hours per week	Total Contact Hours per week
Core, Foundation and Generic Elective **(Only one elective is considered for workload calculations)**	04	04	16
Research Methodology	01	01	01
Practical			
Laboratory	02	06	12 (for One batch) 12 X 02 = 24 (For two batches)
Work Load for Semester I			**40 (For two batches)** 28 (for One batch)
Semester III			
Theory			
Type of Courses	Number of Courses	Contact Hours per week	Total Contact Hours per week
Foundation and Generic Electives **(Only one elective is considered for workload calculations)**	04	04	16
Practical			
Laboratory	01	06	06 (for One batch) 06 X 02 = 12
Research Project	01	18	18 (for One Batch) 18 X 02 = 36 (For two batches)
Work Load for Semester III			**64 (for two batches)** 40 (for one batch)
Total Work Load for Semester I and III			**104** **(for two batches)** **And** 68 (for One batch)

M. Sc. (Electronics)
Semester I (Core and Foundation and Generic Elective Courses)

ELET-111 Electronics System 4 Credits

Learning Objectives:

The course should enable students:
1. To apply FEts for practical applications
2.To apply the generic concept of OP-AMPs for building systems to develop application oriented platforms
3. To gain knowledge that spans traditional to controlled oscillations and monolithic frequency synthesizers
4. To gain operational knowledge of analog/digital timing and counting circuits
5. To gain knowledge of classic treatments on Phase locked loops and frequency to voltage conversion
6. To have insight on active filter operations

Learning Outcomes:

After completion of the course, students are expected to be able to:
Identify necessary system requirements and apply classic concepts of analog and digital electronics to address complex application challenges.

Course Contents:

Unit – I: Field Effect Transistors (Biasing and Amplifiers) (12 Hrs)

Introduction to FET biasing, Biasing configurations (Fixed-bias, Self-bias, Voltage Divider bias, Common-gate), D and E type MOSFET biasing, Combination Networks, Universal J-FET bias curves, Applications

Introduction to FET amplifiers, JFET small signal model, Various configurations (Fixed-bias, Self-bias, Voltage-Divider, Common gate, Common drain), D & E type MOSFETs, Voltage divider configuration of E type MOSFET, Designing FET amplifier networks, Applications

Unit–II: Special Operational Amplifiers, OP-AMP Applications and Non-linear Function Circuits (10 Hrs)

High voltage/high current amplifiers, chopper and chopper stabilized amplifiers, instrumentation amplifier, isolation amplifier, bridge amplifier, Applications

Op-Amp applications – DC voltmeters, V-I converter with floating load, LED Tester, Furnishing Constant current to grounded load, Short Circuit current measurement and I-V conversion,

Measurement of photoconductor current, Current amplifier, Phase Shifter, Temperature to voltage converter

Nonlinear function circuits: limiter, log/anti-log, multiplier/divider, peak detector, comparator (zero crossing detector with hysteresis, voltage level detector with hysteresis, On-off control, voltage level detector with independent adjustment of hysteresis and Center voltage, Set-point controller, Window detector), true RMS/DC converter.

Unit – III: Oscillators, Signal Generators, Timers, Counters **(12 Hrs)**

Sinusoidal and relaxation oscillators: phase shift oscillator, Ring oscillator, Wien-bridge oscillator, quadrature oscillator, crystal oscillator and clock circuits, voltage controlled oscillators – sine, square and triangle, frequency synthesizer, applications

Concept of free running and one-shot configuration, triangle wave generator, sawtooth wave generator, Balance modulator/Demodulator, Universal trigonometric function generator (AD639), Precision sine/square wave generator, applications

Timing and counting circuits, digital counters, shift register, analog and digital timers, frequency counters, PLA and PLD applications, applications

Unit – IV: Phase Locked Loops and F/V conversion and Active Filters **(12 Hrs)**

Phase locked loop, Loop response, Applications of PLL.

Frequency-to-voltage converters: diode pump integrator, frequency and RPM transducers; Phase and phase/frequency comparators – analog and digital, applications

Active filter types, Filter approximations – Butterworth and chebyshev, filter realizations, frequency and impedance, scalings, filter transformations, sensitivity, switched capacitor circuit, applications

Unit - V: **(12 Hrs)**

Presentations, case studies, Assignments, Tutorials based on Module I to IV.

Ref. Books:

1. Sonde, B.S. – Introduction to System design using Integrated Circuits, New Age International (P), NewDelhi.
2. Fitchen, F.C. – Integrated Circuits and Systems, Van Nostrand, New York
3. Coughlin R.S., Driscoll F.F. – Operational amplifiers and Linear Integrated circuits, Prentice hall of India, New Delhi
4. Gayakwad R.A.- Op-Amps and Linear Integrated Circuits, Prentice Hall of India, New Delhi
5. Boylestad R.L., Nashelsky L. – Electronic Devices and Circuit Theory, Pearson Education, New Delhi

ELET-112- Industrial Power Electronics

4 Credits

Learning Objectives:

The course should enable students:

1. To understand concepts of power electronic devices
2. To analyze application requirements of power electronic devices

Learning Outcomes:

After completion of the course, students are expected to be able to:

Identify application sectors and apply power electronic devices for necessary applications.

Unit – I: Thyristor and related Power Devices

(12 Hrs)

THYRISTOR: Thyristor fundamentals, Structure of thyristor, Principle of operation of SCR, Static anode cathode characteristics, Two transistor analogy, gate circuit parameters, Turn-on methods of thristor, Dynamic turn-on switching characteristics, Turn off mechanism.
TRIAC:The Triac,Triac firing circuit.
POWER MOSFETS: Introduction, MOSFET characteristics, Comparison of MOSFET with BJT.
Insulated gate Bipolar transistor(IGBT): Basic structure and working, IGBT Characteristics, Switching characteristics.
Unijunction transistor: Introduction, UJT relaxation oscillator.
Programmable UJT (PUT):Introduction,PUT relaxation oscillator.

Unit – II: Gate Triggering Circuits

(12 Hrs)

Introduction, Firing of thyristors, Pulse Transformers, Optical Isolators, Gate trigger circuits, Resistance firing circuits, Resistance Capacitance firing circuit, Resistor Capacitor full-wave trigger Circuit, UJT as an SCR Trigger, Synchronized Triggering (Ramp Triggering), Phase control using pedestal and ramp triggering.

Unit – III: Phase Controlled Rectifiers

(12 Hrs)

Introduction, Phase angle control, Single phase half-wave controlled rectifier: with resistive load, with inductive load, effect of freewheeling diode.
Single phase full-wave controlled rectifier: with resistive load, with inductive load, effect of freewheeling diode.
Fully controlled bridge rectifier: with resistive load, with resistive inductive load.
Three phase half-wave controlled rectifier: with resistive load, with inductive load, effect of freewheeling diode.

Unit – IV: Inverters and Choppers **(12 Hrs)**

Inverters: Introduction, Thyristor Inverter classification,
Series inverters: Basic Series inverter, Modified series inverter, Three-Phase series inverter, High frequency series inverter, Self-Commuted Inverters.
Parallel Inverters: Basic parallel Inverter, Parallel Inverter with feedback diodes.
Choppers: Introduction, Principle of chopper operation, Control Strategies, Step-up chopper, Step-up/down chopper

Unit - V: **(12 Hrs)**

Presentations, case studies, Assignments, Tutorials based on Module I to IV.

Ref. Books:

1. Power Electronics, M D Singh and K B Khanchandani(TMH), 2004, ISBN0-07-463369-4.
2. Power Electronics, M.S.JamilAsghar, PHI, 2006, ISBN :81-203-2396-3.
3. Principles of Electronics, V.K.Metha ,Rohit Mehta, S. Chand and Company Ltd. 2012, ISBN: 81-219-2450-2.
4. Power Electronics P S Bimbhra Khanna Publishers 1998, ISBN 81-7409-020-7.
5. Electrical circuits and Basic Semiconductor Electroics, PragatiPrakashan Meerut, 2010, ISBN 978-93-5006-302-6.
6. Industrial Electronics, S.N.Biswas, Dhanpat rai and Sons, 1996.

ELET-113 Embedded Systems -I

4 Credits

Learning objectives:

- Give an understanding about the concepts and basic architecture of 8051
- Provide an overview of difference between microprocessor and micro controller
- Provide background knowledge and core expertise in 8 bit microcontroller 8051.
- Study the architecture, various blocks from 8051 , ports, memory organization and various addressing modes of 8051 and various moving op-code.
- Give knowledge about arithmetic operations and jump ranges and instructions.
- Impart knowledge about assembly language programs of 8051
- Help understand the importance of different peripheral devices & their interfacing to 8051
- Impart knowledge of different types of external interfaces including LEDS, LCD, Keypad Matrix, Stepper motor & seven segment displays.

Learning Outcomes :

- The students would learn the basic difference between the microprocessors and microcontroller with the family information.
- The students will learn the architecture and basic function of the microcontroller.
- The students will learn the programming tools which is used for the programming of the microcontroller.
- The students will learn the 8051 microcontroller assembly language program logic. The students will learn hardware interface of the microcontroller with the actual devices like stepper motor, LCD etc.

Course contents:

Unit I: 8051Microcontroller **(12 Hrs)**

An Introduction: Microprocessors and Microcontrollers, comparing microprocessors and Microcontrollers, a Microcontrollers survey, development system for Microcontrollers, 8051 Microcontroller hardware: Block diagram, Programming model, pin diagram, the 8051 oscillator and clock, program counter and data pointer, A and B CPU registers, flags and program status word, internal memory, internal RAM, the stack and the stack pointer, special function registers, internal ROM; Input / output pins, ports and circuits: port pin circuits, port 0, port 1, port 2, port 3; external memory, counters and timers, serial data input / outputs, interrupts.

Unit II: Movingdata and logical operations **(12 Hrs)**

Move Operations: Introduction, addressing modes, external data moves, code memory read only data moves, push and pop op-codes, data exchange, simple programs, Logical operations: Introduction, byte level logical operations, bit level logical operation, rotate and swap operations, examples programs.

Unit III: Arithmetic Operations **(12 Hrs)**

Introduction, flags, instructions affecting flags, incrementing and decrementing, addition: unsigned and signed , multiple byte signed arithmetic, subtraction : Unsigned and signed subtraction, multiplication and division, decimal arithmetic, examples programs;

Unit IV: Jump and call Instructions and applications **(12 Hrs)**

Introduction, the jump and call program range, relative range, Short absolute range, long absolute range. Jumps, bit jumps, byte jumps, unconditional jumps, Calls and subroutine, subroutines, Calls and the stacks, Calls and returns. Interrupts and returns, examples problems. Application of 8051 Microcontroller: Simple programmes using 8051 Microcontroller, Display, generation of waves, Pulse measurements, D/A and A/D conversion, Stepper motor.

Unit - V: **(12 Hrs)**

Presentations, case studies, Assignments, Tutorials based on Module I to IV.

Ref. Books

1. Mazidi M. A., Mazid J. G. i and McKinlay R. D. – The 8051 Microcontroller and Embedded Systems - Pearson, 2nd edition 2013
2. 8051 Architecture, Programming and Interfacing- K.J. Ayala; Penram International
3. Peat Man John B. - Design with Microcontroller, Pearson Edition Asia, 1998
4. Burns, Alan and Wellings, Andy, Real Time Systemand Programming Languages, 2013, Harlow: Addison- Wesley
5. Raj Kamal -Embedded Systems, TMH, New Delhi

ELET-114 Generic Elective – I 4 Credits

8086 Microprocessor and Interfacing

Learning Objectives:

1. To facilitate the students to understand
   a) the concepts of microprocessor and assembly language programming.
   b) the concept of interfacing devices at laboratory as well industrial level
2. To provide an opportunity to the students to enter into entrepreneurship.

Learning Outcome:

1. Students will be able to learn
   a) Microprocessor architecture, physical configuration of memory, logical configuration of memory, microprocessor programming and interfacing.

2. Students will be capable to perform following job

   a) Industrial automation using 8086 interfacing and programming.
   b) Start his / her own small scale industry for manufacturing microprocessor based automated devices.

3. Students will have option to start his / her teaching career either in science or engineering colleges / institutes as this course is included in science as well engineering discipline.

Course Contents:

Unit - I: Introduction **(12 Hrs)**

Overview of Microcomputer structure and operation, memory, input / output, CPU, address bus, data bus, control bus, 8086 microprocessor family overview, **8086 internal architecture:** execution unit, (flag register, general purpose register, ALU), Bus interface unit, segment register, stack pointer register, pointer and index register [Refer Douglas and Hall book for above articles], **Pin out and pin functions of 8086 :** The pin out, power supply requirements, DC characteristics, input characteristics, output characteristics, pin connections (common pins, maximum mode pins and minimum mode pins) **Addressing Modes**: Data addressing modes: Register addressing, Immediate addressing, Direct addressing, register indirect addressing, base plus index addressing, register relative addressing, base relative plus index addressing, Programme memory addressing modes: Direct program memory addressing, relative program memory addressing, indirect program memory addressing; stack memory addressing modes.

Unit - II: Data Movement, Arithmetic and Logical Instructions **(12 Hrs)**

MOV revised: machine language, the opcode, MOD field, register assignments, R/M memory addressing, special addressing, **PUSH/POP** : PUSH, POP, initializing the stack; **Miscellaneous data transfer instructions:** XCHG, IN and OUT, **Arithmetic and Logic Instructions: Addition, subtraction and comparison: Addition:** Register addition, immediateaddition, memory to register addition, array addition,increment addition, addition with carry; **Subtraction:** Register subtraction, immediate subtraction, decrementsubtraction, subtraction with barrow; **Comparison, Multiplication and division**: **Multiplication**: 8 bitmultiplication, 16 bit multiplication; **Division:** 8 bit division,16 bit division; **Basic Logic Instructions:** AND, OR, Ex-OR,TEST, NOT, NEG; **Shift and Rotate: Shift:** left shift, rightshift; **Rotate:** Rotate left, rotate right

Unit - III: Program Control Instructions and Assembly Language Programming **(12 Hrs)**

The Jump Group: **Unconditional jump:** short jump, near jump, far jump, indirect jumps using an index; **Conditional Jumps:** LOOP, conditional LOOPs; **Procedures**: CALL, near CALL, far CALL, indirect memory address, RET; **Machine Controland Miscellaneous Instructions:** Controlling the carry flag bit, wait, HLT, NOP ; **Assembly Language Programming: Assembler directives:** ASSUME, DB, DD, DQ, DT, DW, END, ENDP, ENDS,EQU, EVEN, EXTRN, GLOBAL, GROUP, INCLUDE,LABEL, LENGTH, NAME, OFFSET, ORG, PROC, PTR,PUBLIC, SEGMENT, SHORT, TYPE [Refer Douglas andHall book for above articles **Assembly Language Programming:** Sum of an array, factorial, largest / smallest from given array, sorting of numeric array, square root.

Unit -IV: Input / Out Interfacing (with reference to 8086 Microprocessor) **(12 Hrs)**

Introduction to I/O interface, I/O instructions, isolated and memory mapped I/O, basic input and output interfaces, handshaking, I/O port address decoding: decoding of 8-bit I/O addresses, decoding of 16 – bit I/O address; The programmable peripheral interface: basic description of 8255, programming the 8255, mode 0 operation, an LCD display interfaced to 8255, a stepper motor interfaced to 8255, Mode 1 strobed input, mode1 strobed output , Mode 2 bisectional operation

Unit - V: **(12 Hrs)**

Presentations, case studies, Assignments, Tutorials based on Module I to IV.

References:

1. The Intel Microprocessors, Architecture Programming and interfacing, Barry B Brey ; Sixth Edition ; Prentice Hall International, Publications, **(2002),** ISBN-10: 0130607142, ISBN-13: 978-0130607140

2. The Intel Microprocessors, Architecture Programming and interfacing, Barry B Brey ;Eighth Edition ; Prentice Hall International, Publications **(2009),** ISBN 0-13-502645-8
3. Microprocessors and Interfacing : Programming and Hardware, Douglas V Hall : II Edition ; Tata McGraw-Hill**(1990),** ISBN-10: 0070257426, ISBN-13: 978-0070257429.
4. Microcomputer Systems : The 8086 / 8088 Family; Architecture, Programming and Design, Yu-Cheng Liu and Glenn A. Gibson,Prentice Hall International, Publications **(1986),** ISBN-10: 013580499X, ISBN-13: 9780135804995.
5. The 8086/8088 Family: Design, Programming and Interfacing, John, Uffenbeck, Prentice Hall International, Publications **(1986),** ISBN-10: 0132467526, ISBN-13: 978-0132467520

ELET-114 Generic Elective – I 4 Credits

OPTOELECTRONICS

Learning Objective

1. To familiarize students with physical mechanisms of optoelectronic
2. To train solving computational problems concerning physical parameters and quantities of lasers, fibers, and led diodes

Learning Outcomes

Students will find direction of research in solid state opto electronic device fabrication and characteristics modulation

UNIT- I: Review of Semiconductor Device Physics **(12 Hrs)**

Energy bands in solids, the E-k diagram, Density of states, Occupation probability, Fermi level and quasi Fermi levels, p-n junctions, Schottky junction and Ohmic contacts.
Semiconductor optoelectronic materials, Bandgap modification, Heterostructures and Quantum Wells. Interaction of photons with electrons and holes in a semiconductor:-
Rates of emission and absorption, Condition for amplification by stimulated emission, the laser amplifier.

UNIT- II: Semiconductor Photon Sources **(12 Hrs)**

Electroluminescence. The LED: Device structure, materials and characteristics. The Semiconductor Laser: Basic structure, theory and device characteristics; direct current modulation.
Quantum-well lasers; DFB-, DBR- and vertical-cavity surface-emitting lasers (VCSEL); Laser diode arrays. Device packages and handling.

UNIT-III: Semiconductor Optical Amplifiers & Modulators **(12 Hrs)**

Semiconductor optical amplifiers (SOA), SOA characteristics and some applications, Quantum-confined Stark Effect and Electro-Absorption Modulators.

UNIT-IV: Semiconductor Photodetectors **(12 Hrs)**

Types of photodetectors, Photoconductors, Single junction under illumination: photon and carrier-loss mechanisms, Noise in photodetection;
Photodiodes, PIN diodes and APDs: structure, materials, characteristics, and device performance. Photo-transistors, solar cells, and CCDs. Optoelectronic integrated circuits - OEICs.

Unit - V: **(12 Hrs)**

Presentations, case studies, Assignments, Tutorials based on Module I to IV.

Ref. Books

1. B. E. A. Saleh and M. C. Teich, *Fundamentals of Photonics*, John Wiley & Sons, Inc., 2nd Ed. (2007), Ch.16, 17, and 18.
2. P. Bhattacharya, *Semiconductor Optoelectronic Devices*, Prentice Hall of India (1997).
3. J. Singh, *Semiconductor Optoelectronics: Physics and Technology*, McGraw-Hill Inc. (1995).
4. G. Keiser, *Optical Fiber Communications*, McGraw-Hill Inc., 3rd Ed. (2000), Ch.4, 6.
5. A. Yariv and P. Yeh, *Photonics: Optical Electronics in Modern Communications*, Oxford University Press, New York (2007), 6th Ed. Ch.15-17.
6. J. M. Senior, *Optical Fiber Communication: Principles and Practice*, Prentice Hall of India, 2nd Ed.(1994), Ch.6-8.

ELET-115 Research Methodology

01 Credit

Learning Objectives:

The course should enable students:
1. to define research and describe the research process and research methods
2. to understand qualitative research and methods used to execute and validate qualitative research
3. to know how to apply the basic aspects of the research process in order to plan and execute a research project.
4. to provide insight into the processes that lead to the publishing of research.
5. to be able to present, review and publish scientific articles

Learning Outcomes:

Students will be able to -
1. do systematic literature survey, formulation of a research topic, study design, analysis and interpretation of data.
2. to design a research approach for a specific research issue of their choice.
3. select a suitable analytical method for a specific research approach.
4. demonstrate a good understanding of how to write a research report.
5. critically assess published quantitative research with regard to the statistical methods and approaches adopted

Course Contents:

Unit I : Research Fundamentals **(03 Hrs)**

Introduction: Definition, objectives of the research, characteristics of the research, what makes people to do research, importance of research.

Unit II : Identification of Research Problem **(03 Hrs)**

Defining the research problem: Identification of research problems, selection of research problem, facts one should know regarding selection of research problem, the process of research problem definition, some facts involved in defining research problem

Unit III : Formulation of Research Problem **(03 Hrs)**

Formulation of the problems: steps involved in defining a problem, formulation of the problems, Formulation of hypothesis: Concept of hypothesis, hypothesis testing, Developing the research plan: implementation, interpreting and reporting the findings, Importance of hypothesis of in decision making.

Unit IV : Research Report and Proposal Writing **(03 Hrs)**

Introduction, research proposal writing: costing, the research proposal, rationale for the study, research objectives, research methodology, target respondents, research Centres, sample size and sample composition, sampling procedures, research project execution, research units; An insight into research report and proposal, research project synopsis, research report writing : types of research reports, guidelines for writing reports; Steps in writing report, report presentation, typing the report, documentation and bibliography, formatting guidelines for writing a good research report / research paper.

Unit V: Presentations, case studies, Assignments, Tutorials based on Module I to IV.

Ref. Books:

1. Research Methodology by Dr. S. L. Gupta, Hitesh Gupta; International Book House Pvt Ltd (**2013),** ISBN-10: 8191064278, ISBN-13: 978-8191064278

2. Basic Research Methods-Gerard Guthrie SAGE Publications, India, Pvt Ltd, New Delhi (**2010),** ISBN-10: 8132104579, ISBN-13: 978-8132104575

3. Research Methodology-methods and techniques By C. R. Kothari, New Age International Publishers (**2011)** ISBN 978-81-224-1522-3

4. Principles of Research Methodology- Phyllis G. Supino, Jeffrey S. Borer; Springer, Verlag New York **(2012),** ISBN-ebook: 1461433592, ISBN (Hardcover): 978-1461433590

5. Research Design Qualitative, Quantitative. and Mixed Methods Approaches- John W. Creswell; SAGE Publications Ltd, UK **(2011),** ISBN-9780857023452

6. Research Methodology -A Step-by-Step Guide for Beginners- Ranjit Kumar; Sage Publications Ltd **(2010),** ISBN- 1849203016.

7. Scientific Writing and Communication- Angelika Hofmann; Oxford University Press, US **(2010),** ISBN-13-: 978-0 199947560, ISBN-10: 01 99947562

8. Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded- Joshua Schimel, Oxford University Press, **(2011),** ISBN: 9780199760237

9. Handbook of Scientific Proposal Writing- A.Yavuz Oruc; CRC Press, Taylor & Francis group **(2011),** ISBN: 9781439869185

ELEL- 121

Lab course 1 (based on ELET-111 and ELET-112) - 3 Credits

List of Experiments:

1. Study of Instrumentation amplifier
2. Study of window comparator
3. Study of Phase shift/ Wien bridge oscillator
4. Study of typical monolithic frequency synthesizer
5. Study of voltage controlled oscillator
6. Study of PLL
7. Study of digital counters (any two types, pertinent to topics taught in theory)
8. Study of DC characteristics of SCR
9. Study of firing circuit for SCR (any one type)
10. Study of DIAC
11. Study of TRIAC
12. Study of the effects of variation of R, C in R and RC triggering circuits on firing angle and output voltage of SCR.
13. Study of the output waveforms of single phase full wave controlled rectifier with R, RL load, freewheeling diode and measure load voltage.
14. Study of the effect of firing angle on output voltage in DIAC - TRIAC phase control circuit.
15. Study of Step UP chopper (with SCR/MOSFET/Transistor)
16. Study of Step Down chopper (with SCR/MOSFET/Transistor)

(Students should submit one individual project employing OP-AMP and/or Power Electronic