# DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY

## CIRCULAR NO.SU/Sci./M.Sc.Electronics/51/2021

It is hereby inform to all concerned that, the syllabus prepared by the Board of Studies in Electronics and recommended by the Dean, Faculty of Science & Technology the Hon'ble Vice-Chancellor has accepted the **Syllabus of M.Sc. Electronics Ist to IVth semester with Bridge Course for affiliated Colleges and University Department** in his emergency powers under section 12(7) of the Maharashtra Public Universities Act, 2016 on behalf of the Academic Council as appended herewith.

This shall be effective from the Academic Year 2021-22 and onwards.

All concerned are requested to note the contents of this circular and bring notice to the students, teachers and staff for their information and necessary action.

University Campus,
Aurangabad-431 004.
REF.NO. SU/SCI/2021/3858-67
Date:- 25.11.2021.

*Deputy Registrar,*
*Academic(Syllabus) Section.*

**Copy forwarded with compliments to :-**

1] **The Principal of all concerned Colleges,**
Dr. Babasaheb Ambedkar Marathwada University,
2] **Head of the Department, Department of Electronics,**
Dr.Babasaheb Ambedkar Marathwada University, Aurangabad.
3] **The Director, University Network & Information Centre, UNIC, with a request to upload this Circular on University Website.**

**Copy to :-**

1] The Director, Board of Examinations & Evaluation,Dr.BAMU,A'bad.
2] The Section Officer,[M.Sc.Unit] Examination Branch,Dr.BAMU,A'bad.
3] The Programmer [Computer Unit-1] Examinations, Dr.BAMU,A'bad.
4] The Programmer [Computer Unit-2] Examinations, Dr.BAMU,A'bad.
5] The In-charge,[E-Suvidha Kendra], Rajarshi Shahu Maharaj Pariksha Bhavan, Dr.BAMU,A'bad.
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# Dr. Babasaheb Ambedkar Marathwada University

**Aurangabad - 431004 (MS) India**

# Master of Science (M. Sc.) in Electronics

## Course Structure and Curriculum

**(Outcome based Curriculum)**

**Choice Based Credit System**

**(Effective from Academic Year 2021-22)**

**Dr. Babasaheb Ambedkar Marathwada University**

**Aurangabad – 431004 (MS) India**

25/08/2021
Dean
Faculty of Science & Technology
Dr. Babasaheb Ambedkar Marathwada University, Aurangabad

25/08/2021
Prof M.D. Shirsat
Chairman - BoS in Electronics

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# PREFACE

Outcome Based Education (OBE) is the educational approach which focuses on student centric education in the context of development of personal, social, professional and knowledge (KSA) requirements in one's career and life. It is the decade ago curriculum development methodology. The educational triangle of *LEARNING-ASSESSMENT-TEACHING* is the unique nature of the OBE approach. The curriculum practices such as Competency Based Curriculum, Taylor's Model of Curriculum Development, Spadys' Curriculum principles, Blooms taxonomy and further use of assessment methodologies like, Norm-reference testing and Criterion reference testing, etc is being practiced since decades. It is also interesting to know that, globally, different countries and universities adopts the curriculum development models/approaches such as, CDIO (Conceive-Design-Implement-Operate), Evidenced Based Education, Systems' Approach, etc as the scientific and systematic approaches in curriculum design.

The authorities of Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (M.S.) in-lieu of accreditation standards of National Assessment and Accreditation Council, decided to opt for Outcomes Based Education (OBE). As the part of the decision, different meetings, workshops and presentations were held at the campus of university.

This document is the outcome of different meetings and workshops held at university level and department level. The detailed document is designed and the existing curriculum of the department is transformed in to the framework of OBE. This is the first step towards the implementation of OBE in the university departments and affiliated colleges. The document will serve all stakeholders in the effective implementation of the curriculum. The OBE is continuous process for quality enhancement and it will go a long way in order to enhance the competencies and employability of the graduates/Post-graduates of the university departments and affiliated colleges.

# Structure and Curriculum for

# Master of Science (M. Sc.) in Electronics

## (Choice Based Credit System)

This M. Sc. Electronics program is divided in four semesters having 104 credits. The distribution or credits is as per following –

| Sr. No. | Category of course(s) | Type of Course (Theory/ Practical/ Research Project) | Number of Course(s) | Total Credits | Semester-wise Credit Distribution |
|---|---|---|---|---|---|
| 1 | Compulsory Common Component (Constitution of India) | Theory | 01 | 02 | Sem I - 02 |
| 2 | Core and Foundation Component | Theory | 10 | 38 | Sem I - 18<br>Sem II - 08<br>Sem III - 08<br>Sem IV- 04 |
| 3 | Generic Elective | Theory | 06 | 24 | Sem II - 08<br>Sem III - 08<br>Sem IV- 08 |
| 4 | Open Elective ( Service Course) | Theory | 01 | 04 | Sem IV- 04 |
| 4 | Laboratory courses (Core, Foundation and Generic Elective ) | Practical | 08 | 24 | Sem I - 06<br>Sem II - 06<br>Sem III - 06<br>Sem IV- 06 |
| 05 | Research Component | Research Project | 04 | 12 | Sem I - 03<br>Sem II - 03<br>Sem III - 03<br>Sem IV- 03 |
| **Total** | | | | **104 Credits** | |

**The above structure exercised component wise distribution as per following –**

| | | |
|---|---|---|
| Constitution of India | = | 02 Credits |
| Core and Foundation Courses | = | 42 % |
| Elective Courses | = | 27 % |
| Laboratory Courses | = | 35 % |

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# Structure of M. Sc. (Electronics)

| Semester I (Core and Foundation Courses) | | | | |
|---|---|---|---|---|
| **Course** | **Course Title** | **Teaching time/week** | **Marks** | **Credits** |
| ELET-111 | Electronic Devices | 4 hours | 100 | 4 |
| ELET-112 | Industrial Electronics | 4 hours | 100 | 4 |
| ELET-113 | Sensor Fundamentals | 4 hours | 100 | 4 |
| ELET-114 | Network Analysis and Synthesis | 4 hours | 100 | 4 |
| ELET-115 | Research Methodology | 2 hours | 50 | 2 |
| ***COM-100*** | ***Constitution of India*** | ***2 hours*** | ***50*** | ***2*** |
| ELEL-121 | Lab course 1 (based on ELET-111 and ELET-112 ) | 6 hours | 100 | 3 |
| ELEL-122 | Lab course 2 (based on ELET-113 and ELET-114 ) | 6 hours | 100 | 3 |
| ELER-131 | Research Project - Part I (Review of literature and Formulation of Topic for Research Project) | 6 hours | 100 | 3 |
| Total Credits of **Semester I: 29** (Theory: 20; Laboratory: 06; Research Project: 03) | | | | |
| **Semester II (Foundation and Generic Elective Courses)** | | | | |
| ELET-211 | 8086 Microprocessor and Interfacing | 4 hours | 100 | 4 |
| ELET-212 | Embedded System and Interfacing | 4 hours | 100 | 4 |
| ELET-213 | Generic Elective - I<br>i. Properties of Electronic Materials<br>ii. Control Systems<br>iii. Signal Conditioning Circuits | 4 hours | 100 | 4 |
| ELET-214 | Generic Elective - II<br>i. Advanced Sensor Technology<br>ii. Process Control Fundamentals<br>iii. Biomedical Instrumentation - I | 4 hours | 100 | 4 |
| ELEL-221 | Lab course 3<br>(based on ELET-211 and ELET-212) | 6 hours | 100 | 3 |
| ELEL-222 | Lab course 4<br>(based on ELET-213 and ELET-214) | 6 hours | 100 | 3 |
| ELER-231 | Research Project - Part II (Experimental Work) | 6 hours | 100 | 3 |
| Total Credits for **Semester II: 25** (Theory: 16; Laboratory: 06; Research Project: 03) | | | | |



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| Semester III (Foundation and Generic Elective Courses) | | | | |
|---|---|---|---|---|
| ELET-311 | Programmable Logic Controllers | 4 hours | 100 | 4 |
| ELET-312 | Internet of Things | 4 hours | 100 | 4 |
| ELET-313 | Generic Elective - III<br>i. Fabrication Techniques for Electronic Devices<br>ii. Instrumentation in Process Control<br>iii. Smart Fusion Technology based System Design | 4 hours | 100 | 4 |
| ELET-314 | Generic Elective - IV<br>i. Characterization Techniques for Electronic Devices<br>ii. Automated Process Control<br>iii. Biomedical Instrumentation - II | 4 hours | 100 | 4 |
| ELEL-321 | Lab course 5 (based on ELET-311 and ELET-312) | 6 hours | 100 | 3 |
| ELEL-322 | Lab course 6 (based on ELET-313 and ELET-314) | 6 hours | 100 | 3 |
| ELER-331 | Research Project - Part III (Experimental Work along with Analysis and Interpretation Results) | 6 hours | 100 | 3 |
| Total Credits for **Semester III: 25** (Theory: 16; Laboratory: 06; Research Project: 03) | | | | |
| **Semester IV (Foundation, Generic and Open Elective Courses)** | | | | |
| ELET-411 | Advance Communication Systems | 4 hours | 100 | 4 |
| ELET-412 | Generic Elective - V<br>i. Electrochemical Energy Storage Systems<br>ii. Micro-electromechanical System and Applications<br>iii. Solar Photovoltaic Systems<br>iv. PC Based Instrumentation | 4 hours | 100 | 4 |
| ELET-413 | Generic Elective - VI<br>i. Optoelectronics and Optical Fiber Communication<br>ii. HMI, SCADA basics and Databases<br>iii. Electronics and Automation in Agriculture | 4 hours | 100 | 4 |
| ELET-414 | Open Elective ( Service Course) from Other Department | 4 hours | 100 | 4 |
| ELEL-421 | Lab course 7 (based on ELET-411 and ELET-412) | 6 hours | 50 | 3 |
| ELEL-422 | Lab course 8 (based on ELET-413) | 6 hours | 50 | 3 |
| ELER-431 | Research Project - Part IV (Experimental Work along with Analysis, Interpretation Results, Drafting of Manuscript for Publication and Dissertation) | 6 hours | 50 | 3 |
| Total Credits for **Semester IV : 25** (Theory: 16; Laboratory: 06; Research Project: 03) | | | | |
| **Total Credits :104 ( Sem I: 29 + Sem II: 25 + Sem III: 25 + Sem IV: 25)** | | | | |



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**Preamble:**

Dr. Babasaheb Ambedkar Marathwada University proposes to offer a two year Master programme in Science (M. Sc.) in Electronics. The curriculum design of this program is undertaken in the following framework (assumptions).

a) Although there has been remarkable progress in all sectors of education in last couple of decades, there has been increasing crisis for truly able manpower to address the growing demands for work sectors. This has led to the widening gap between the supply and demand for skilled manpower across teaching institutions, R&D organizations and industries. Such inadequacy of knowledge acquisition and dissemination has translated directly into unemployment among an increasing number of post-graduates who pass-out every year and are forced to bare-trained in order to become marketable.

   A scientifically designed framework, which will enable students at post graduate level to be ready to face the challenges of the demand driven socio-economic profile is therefore, a call of the day. Such a course should not be occupation specific and should enable students to choose from a variety of options for their career.

   **This programme is designed to produce a skilled manpower in Electronics with Sensors and process control as specialized sectors of training to improve the opportunities for the unemployed youths in both the private and public sectors.**

b) According to a study conducted by the Associated Chambers of Commerce and Industry of India (ASSOCHAM), there will be a deficit of 40 million working professionals and the employers would face the difficulty of filling positions because of the dearth of suitable talent and skilled person all in their industry. **This programme aims to provide some solution for this problem and this would facilitate to improve:**

   **(i) Quality of training**
   **(ii) High drop-out rates**
   **(iii) Linkages with Universities and industry**
   **(iv) Inadequacy of resources.**

c) **This programme is intended to offer practical training and skills needed to pursue an occupation straight away. It will provide options to the students to be trained in directions which are directly aligned to land a job in a chosen profession or a skilled trade.**

d) **This program is intended to offer students with life-long independent and reflective learning skills in their career.**

## Vision

To structure the Department of Electronics of University and affiliated colleges of this university to be an Epitome of Excellence in Research and Development in the area of Sensors and Process Control by creating and imparting time responsive Quality Education to address Changing Scenario, keeping Research and Development at its core, for 'Anyone' at 'Anytime' and 'Anywhere'.

## Mission

To achieve the vision, the Department / College will:

- Provide a platform for the students with broad spectrum of diversity to achieve Academic Excellence with in-built Employability in the area of Sensors and Process Control.
- Establish a unique learning environment to enable the students to face the challenges in the area of Sensors and Process Control.
- Identify the gaps between academics and industry, design the courses to impart technical and life skill as per the requirements of the region so as to improve employability and develop entrepreneurial capabilities.
- Adopt a perennial process for bringing in excellence in teaching pedagogy by providing ICT based state-of-the-art infrastructural facilitation
- Provide student centric learning environment and to establish platform for inclusive research leading to the development of creative thought process amongst research scholars keeping in mind societal needs.
- Establish centre of excellence in the area of Electronics devices (viz. Sensors, Sensor Networks, semiconductor devices, photovoltaic devices etc) to nurture innovative ideas shaping into products facilitating the spinoff and creating awareness to protect Intellectual Property (IP).
- Provide ethical and value based education by promoting activities addressing the societal needs.

## Program Educational Objectives:

The objectives of M. Sc. (Electronics) program are to produce graduates who -

1. Are equipped with time relevant knowledge of Sensors and Process Control to address multi-disciplinary demands of R & D organizations, educational institutes and automated process in modern industries in capacity of Scientist, Education Professionals, System Developers and System Integrators.
2. Have sound background to practice advanced concepts of electronics in the areas sensor technology, Semiconductor Devices, Process controls in R & D organizations, educational institutes, industry and Government settings meeting the growing expectations of stakeholders.
3. Have an ability to pursue higher studies and succeed in academic and professional careers.
4. Have the ability to address professional demands individually and as a team member communicating effectively in technical environment using modern tools.
5. Recognize the need for and possess the ability to engage in lifelong learning and will be sensitive to consequences of their work both ethically and professionally for productive professional career.

## Programme Outcomes (POs):

**Graduates of the M. Sc. (Electronics) program are expected to -**

PO1. **The citizenship and society:** Apply broad understanding of ethical and professional skill in electronics technology in the context of global, economic, environmental and societal realities while encompassing relevant contemporary issues.

PO2. **Environment and sustainability**: Apply broad understanding of impact of electronics technology in a global, economic, environmental and societal context and demonstrate the knowledge of, and need for sustainable development.

PO3. **Ethics:** Apply ability to develop sustainable practical solutions for electronics technology related problems within positive professional and ethical boundaries.

PO4. **Individual and team work:** Function effectively as a leader and as well as team member in diverse/ multidisciplinary environments.

PO5. **Communication:** Communicate effectively on complex electronics technology related activities with the scientific community in particular and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO6. **Project management and finance**: Demonstrate knowledge and understanding of the first principles of electronics technology and apply these to one's own work as a member and leader in a team, to complete project in any environment.

PO7. **Life-long learning**: Recognize the need for lifelong learning and have the ability to engage in independent and life-long learning in the broadest context of technological change.

## Programme Specific Outcomes:

PSO1. **Domain knowledge:** Apply the knowledge of electronics fundamental, Sensor Technology, Semiconductor Devices, and Process Control to provide comprehensive solution of problems in complex electronics.

PSO2. **Problem Analysis:** Identify electronics related problems at varied complexity and analyze the same to formulate/ develop substantiated conclusion using first principles of Sensor Technology, Semiconductor Devices, Process Control and scientific literature.

PSO3. **Design Development of solutions:** Design/ develop solutions for problems at varied complexity in the area Sensor Technology, Semiconductor Devices, and Process Control to address changing challenges put forward by market demand/ stakeholder

PSO4. **Conduct Investigation of complex problems:** Use research-based knowledge and methods to design of experiments, analyze resulting data and interpret the same to provide valid conclusions.

PSO5. **Modern tools:** Create, select, and apply appropriate techniques, resources, and modern electronics and relevant IT tools including prediction and modeling to complex electronics technology related activities with clear understanding of the limitations

## Course - Program outcome Matrix:

The Program Outcomes are developed through the curriculum (curricular/co-curricular-extra-curricular activities). The program outcomes are attained through the course implementation. As an educator, one must know, ***"to which POs his/her course in contributing?"*** So that one can design the learning experiences, select teaching method and design the tool for assessment. Hence, establishing the Course-PO matrix is essential step in the OBE. The course-program outcomes matrix indicates the co-relation between the courses and program outcomes. The CO-PO matrix is the map of list of courses contributing to the development of respective POs.

**The CO-PO MATRIX is provided in the below table.**

| Course | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ELET-111 | | | | √ | | | √ | √ | √ | √ | √ | √ |
| ELET-112 | | | | √ | | | √ | √ | √ | √ | √ | √ |
| ELET-113 | | | | √ | | | √ | √ | √ | √ | √ | √ |
| ELET-114 | | | | √ | | | √ | √ | √ | √ | √ | √ |
| ELET-115 | | | | | √ | √ | √ | √ | √ | √ | √ | √ |
| *COM-100* | √ | √ | √ | | | | √ | | | | | |
| ELEL-121 | | | | | | | √ | | | | | |
| ELEL-122 | | | | | | | √ | | | | | |
| ELER-131 | | | | | √ | √ | √ | √ | √ | √ | √ | √ |
| ELET-211 | | | | | | | √ | | | | | |
| ELET-212 | | | | √ | | | √ | √ | √ | √ | √ | √ |
| ELET-213 | | | | √ | | | √ | √ | √ | √ | √ | √ |
| ELET-214 | | | | √ | | | √ | √ | √ | √ | √ | √ |
| ELEL-221 | | | | √ | | | √ | √ | √ | √ | √ | √ |
| ELEL-222 | | | | √ | | | √ | √ | √ | √ | √ | √ |
| ELER-231 | | | | | √ | √ | √ | √ | √ | √ | √ | √ |
| ELET-311 | | | | √ | | | √ | √ | √ | √ | √ | √ |
| ELET-312 | | | | √ | | | √ | √ | √ | √ | √ | √ |
| ELET-313 | | | | √ | | | √ | √ | √ | √ | √ | √ |
| ELET-314 | | | | √ | | | √ | √ | √ | √ | √ | √ |
| ELEL-321 | | | | √ | | | √ | √ | √ | √ | √ | √ |
| ELEL-322 | | | | √ | | | √ | √ | √ | √ | √ | √ |
| ELER-331 | √ | √ | √ | | √ | √ | √ | √ | √ | √ | √ | √ |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ELET-411 | | | | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| ELET-412 | | | | √ | | | √ | √ | √ | √ | √ | √ |
| ELET-413 | | | | √ | | | √ | √ | √ | √ | √ | √ |
| ELEL-421 | | | | | √ | √ | √ | √ | √ | √ | √ | √ |
| ELEL-422 | | | | | √ | √ | √ | √ | √ | √ | √ | √ |
| ELER-431 | √ | √ | √ | | √ | √ | √ | √ | √ | √ | √ | √ |
| ELER-432 | √ | √ | √ | | √ | √ | √ | √ | √ | √ | √ | √ |

## Target levels for Attainment of Course Outcomes:

The course outcome attainment is assessed in order to track the graduates' performance w.r.t target level of performance. The CO-PO attainment is the tool used for continuous improvement in the graduates' abilities through appropriate learning & teaching strategies. In order to assess students' performance with respect to abilities (at the end of course teaching/by the end of program) the course outcome attainment are measured/calculated. In order to calculate the program outcome attainment, the course outcome attainment is calculated. Prior to that, the course-program outcome mapping is done.

## Target level for Attainment of Program Outcomes:

The program outcome attainment is assessed in order to track the graduates' performance w.r.t target level of performance. The CO-PO attainment is the tool used for continuous improvement in the graduates' abilities through appropriate learning and teaching strategies. In order to assess students' performance with respect to abilities (at the end of course teaching/by the end of program) the course outcome attainment and program outcome attainment is measured/calculated. The program outcome attainment is governed by curricular, co-curricular and extra-curricular activities including the stakeholders' participation. The direct method and indirect method is adopted to calculate the PO attainment. The direct method implies the attainment by course outcomes contributing to respective program outcomes. And indirect method is the satisfaction/feed-back survey of stakeholders. In order to calculate the program outcome attainment, the course outcome attainment is calculated. Prior to that, the course-program outcome mapping is done.

The set target level is the set benchmark to ensure the continuous improvements in the learners/ graduates' performance.

## Course Attainment Levels:

a. CO attainment is defined/set at three levels;
b. The CO attainment is based on end term examination assessment and internal assessment;
c. The Co attainment is defined at three levels in ascending order-
    i. e.g. For end term and internal examination;
    ii. Level-1: 20% students scored more than class average
    iii. Level-2: 30% students score more than class average;
    iv. Level-3: 40% students score more than class average.
d. The target level is set (e.g. Level-2). It indicates that, the current target is level-2; 30% students score more than class average. The CO attainment is measured and the results are obtained. Based on the results of attainment, the corrective measures/remedial action are taken.
e. CO Attainment = 80% (Attainment level in end term examination) + 20% (Attainment level in internal examination).

## Program attainment Level:

a. PO attainment is defined at five levels in ascending order;
b. The PO attainment is based on the average attainment level of corresponding courses (Direct Method) and feed-back survey (Indirect method);

c. The PO attainment levels are defined / set as stated below;
   i. Level-1: Greater than 0.5 and less than 1.0 (0.5>1) - Poor
   ii. Level-2: 1.0>1.5 - Average
   iii. Level-3: 1.5>2.0 - Good
   iv. Level-4: 2.0>2.5 - Very Good
   v. Level-5: 2.5>3.0 - Excellent

d. The PO attainment target level is set/defined (say, Level-4). It implies that, the department is aiming at minimum level-4 (very good) in the performance of abilities by the graduates. Based upon the results of attainment, the remedial measures are taken;

e. PO Attainment = 80% (Average attainment level by direct method) + 20% (Average attainment level by indirect method).

## Examples of CO Attainment:

**FOR EXAMPLE: COURSE CODE/TITLE: ELET-214-1**

e.g. For end term and internal examination;

i. Level-1: 20% students scored more than class average
ii. Level-2: 30% students score more than class average;
iii. Level-3: 40% students score more than class average

Average of Total Marks in Examination: 61.00

% Students score more than 61 is 4/12 i.e. 33.33% i.e. Levl-2

A (CO) ELET-214-1 = 100(2)

= 2.00

**Hence**, the attainment level is Level-2 and the set target level is Level-2 and therefore the CO is fully attained.

**Table No. 1.0: CO Attainment Level**

| Course Code | CO attainment Value | Attainment | Fully Attained/Not attained | Remedial measures |
|---|---|---|---|---|
| ELET-111 | 1 | 2 | Not Attained | Assignment, tutorials, exercise and Remedial coaching. |
| ELET-112 | 2 | 2 | Fully Attained | |
| ELET-113 | 1 | 2 | Not Attained | Assignment, tutorials, exercise and Remedial coaching. |
| ELET-114-1 | 3 | 2 | Fully Attained | |
| ELET-115 | 3 | 2 | Fully Attained | |
| ELEL-121 | 2 | 2 | Fully Attained | |

| | | | | |
|---|---|---|---|---|
| ELEL-122 | 0 | 2 | Not Attained | Assignment, tutorials, exercise and Remedial coaching. |
| ELER-131 | 3 | 2 | Fully Attained | |
| ELET-211 | 3 | 2 | Fully Attained | |
| ELET-212 | 1 | 2 | Not Attained | Assignment, tutorials, exercise and Remedial coaching. |
| ELET-213-1 | 3 | 2 | Fully Attained | |
| ELET-214-1 | 2 | 2 | Fully Attained | |
| ELEL-221 | 3 | 2 | Fully Attained | |
| ELER-231 | 0 | 2 | Not Attained | Assignment, tutorials, exercise and Remedial coaching. |

**Example of PO Attainment:**

The attainment of PO will have to be calculated after declaration of II$^{nd}$ year result every year.

**Table No. 2.0 PO Attainment Level**

| PO/PSO number | Description of PO/PSO | Attainment level | Target level | Fully attained/ Not Attained | Remedial Measures |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

1. **Planned Actions for Course Attainment:**

2. **Planned Actions for Program Outcome Attainment:**

After calculating attainment of COs and POs, gap needs to be identified and a comprehensive plan needs to be prepared for bridging the gaps.

## Eligibility:

Candidates seeking admission to the first Semester of M. Sc. in Electronics must possess following eligibility criteria.

- Must have passed B. Sc., (10 + 2 + 3) degree with Electronics OR Physics as one of the optional subjects OR have passed B. Sc. (Hons.) with electronics OR Physics.

  OR

- Must have passed B. Voc degree with Industrial Automation

  OR

- Must have passed B. E. / B. Tech with Electronics & Telecommunication Engineering / Electronics Engineering / Instrumentation Engineering

## Course Fees:

Rs. 25,000/- per year

## Number of Seats: 30

The Intake capacity of M. Sc. Electronics will be 30 as under 'Self Finance Mode'

## Admission / Promotion Process:

In response to the advertisement for registration, interested students will have to register themselves. One of the following methods will be adopted for admission.

- Admission will be done on the basis of performance of students at Common Entrance Test (CET). The CET will be conducted in the month of June every year.

  OR

- Admission process declared by the University

There is Full Carry on for M. Sc i.e. **irrespective** of individual performance in first year; a student will be promoted to Second Year. However, for obtaining M. Sc. Degree, a student will have to complete all semesters successfully within 4 years/08 semesters.

Dropout students will be allowed to register for respective semester as and when the concerned courses are

offered by the department, **HOWEVER HE / SHE SHOULD NOT EXCEED MORE THAN TWICE THE DURATION OF THE COURSE FROM THE DATE OF FIRST REGISTRATION AT PARENT DEPARTMENT / COLLEGE.** The admission of the concern student will be automatically cancelled if he / she fail to complete the M. Sc. degree within a period of maximum four years / eight semesters.

## Choice Based Credit System (CBCS):

The choice based credit system is going to be adopted by the University. This provides flexibility to make the system more responsive to the changing needs of our students, the professionals and society. It gives greater freedom to students to determine their own pace of study. The credit based system also facilitates the transfer of credits. Students will have to earn 104 credits for the award of two years Master of Science (M. Sc.)

## Credit-to-contact hour Mapping:

(a) One Credit would mean equivalent of 15 periods of 60 minutes each for theory lecture.

(b) For lab course/ workshops/internship/field work/project, the credit weightage for equivalent hours shall be 50% that for lectures /workshop

(c) For self-learning, based on e-content or otherwise, the credit weightage for equivalent hours of study should be 50% or less of that for lectures/workshops.

## Attendance:

Students must have 75 % of attendance in each course for appearing examination, otherwise he / she will be strictly not allowed for appearing the semester examination of each course. Frequent absence from regular lecture/practical course may lead to disqualification from continuous internal assessment (CIA) process in respective subject.

## Departmental Committee (Only for University Department):

The Departmental Committee (DC) of the Department will monitor smooth functioning of the program.

## Results Grievances / Redressal Committee

Grievances / redressal committee will be constituted in the department / college to resolve all grievances relating to the evaluation. The committee shall consist of Head of the department, the concerned teacher of a particular course and senior faculty member of Department of Committee. The decision of Grievances / redressal committee will have to be approved by Department committee.

## Evaluation Methods:

- The assessment will be based on **20:80 ratio** of **continuous internal assessment (CIA) and semester end examination** (SEE). **Separate and independent passing in CIA and SEE will be mandatory**. In case of failure in CIA of a particular course, students will have to appear for the same CIA, at his/her own responsibility in the next academic year, when the same course is offered during regular academic session. However, in case of failure in SEE in particular course(s), exam will be conducted in immediate subsequent semester.

- In case a student fails in certain course(s) in a particular semester and the same course(s) are modified/ revised/ removed from the curriculum in due course, the student will have to appear as per the newly framed curriculum and/or pattern in subsequent semester, at his/her own responsibility.

**Continuous Internal Assessment (CIA):**

There will be 20 marks for Continuous Internal Assessment. Two internal tests (20 marks each) will be conducted during semester as a part of continuous assessment. At the end of the semester, average of two tests will be considered for calculation of final marks.

**Semester End Examination (SEE):**

- The semester end theory examination for each theory course will be of 80 marks. The total marks shall be 100 for 4 credit theory course (80 marks SEE + 20 marks CIA) and 50 for 2 credit theory course (40 marks SEE + 10 marks CIA)

- Semester end examination (SEE) time table will be declared by the University (as per the university annual calendar). The paper setting and assessment of theory courses, laboratory courses and research project will done by external (50%) and internal (50%) examiners appointed by the University.

- Pattern of semester end examination question paper will be as below:
  - The semester end examination of theory course will have two parts (20 + 60 = 80 Marks)
  - Part A will be consisting of 10 questions having 2 marks each (multiple choice questions / fill in the blanks/ answer in sentence) as compulsory questions and it should cover entire course curriculum (20 Marks)
  - Part B will carry 8 questions (12 marks for each question) (02 questions from each of 04 units) and students will have to attempt any 05 questions out of 08 (60 Marks).
  - 20 to 30% weightage can be given to problems/ numerical wherein use of non-programmable scientific calculator may be allowed.
  - Number of sub questions (with allotment of marks) in a question may be decided by the examiner.

**Earning Credits:**

At the end of every semester, a letter grade will be awarded in each course for which a student had registered. A student's performance will be measured by the number of credits that he/she earned by the weighted Grade Point Average (GPA). The SGPA (Semester Grade Point Average) will be awarded after completion of respective semester and the CGPA (Cumulative Grade Point Average) will be awarded at the final exit.

**Grading System:**

- The grading reflects a student-own proficiency in the course. A ten point rating scale shall be used for the evaluation of the performance of the students to provide letter grade for each course and overall grade for the Master Programme. Grade points are based on the total number of marks obtained by him / her in all heads of the examination of the course. The grade points and their equivalent range of marks are shown in Table-I

**Table - I: Ten point grade and grade description**

| Marks Obtained (%) | Grade Point | Letter Grade | Description |
|---|---|---|---|
| 90-100 | 9.00- 10 | O | Outstanding |
| 80-89 | 8.00-8.99 | $A^{++}$ | Exceptional |
| 70-79 | 7.00-7.99 | $A^{+}$ | Excellent |
| 60-69 | 6.00-6.99 | A | Very Good |
| 55-59 | 5.50-5.99 | $B^{+}$ | Good |
| 50-54 | 5.00-5.49 | B | Fair |
| 45-49 | 4.50-4.99 | $C^{++}$ | Average ( Above) |
| 41-44 | 4.1-4.490 | C | Average |
| 40 | 4.0 | P | Pass |
| < 40 | 0.0 | F | Fail ( Unsatisfactory) |
| | 0.0 | AB | Absent |

- Non-appearance in any examination / assessment shall be treated as the students have secured zero marks in that subject examination / assessment.
- Minimum P grade (4.00 grade points) shall be the limit to clear / pass the course / subject. A student with F grade will be considered as "failed" in the concerned course and he / she has to clear the course by appearing in the next successive semester examinations.
- Every student shall be awarded grade points out of maximum 10 points in each subject (based on 10 point scale). Based on the grade points obtained in each subject, Semester Grade Point Average (SGPA) and then Cumulative Grade Point Average (CGPA) shall be computed. Results will be announced at the end of each semester and CGPA will be given at final exit.

**Computation of SGPA (Semester Grade Point Average) and CGPA (Cumulative Grade Point Average)**

Grade in each subject / course will be calculated based on the summation of marks obtained in all five modules.

The computation of SGPA and CGPA will be as below

- Semester Grade Point Average (SGPA) is the weighted average points obtained by the students in a semester and will be computed as follows

$$SGPA = \frac{\text{Sum (Course Credits) X Number of Grade Points in concerned Course Gained by the Student}}{\text{Sum (Course Credits)}}$$

The SGPA will be mentioned on the grade card at the end of every semester.

- The Cumulative Grade Point Average (CGPA) will be used to describe the overall performance of a student in all semester of the course and will be computed as under.

$$CGPA = \frac{\text{Sum (All four Semester SGPA)}}{\text{Total Number of Semester}}$$

The SGPA and CGPA shall be rounded off to the second place of decimal.

**Grade Card**

Results will be declared by the Centre and the grade card (containing the grades obtained by the student along with SGPA) will be issued by the university after completion of every semester. The grade card will be consisting of following details.

- Title of the courses along with code opted by the student.
- Credits associated with the course.
- Grades and grade points secured by the student.
- Total credits earned by the student in a particular semester.
- Total credits earned by the students till that semester.
- SGPA of the student.
- CGPA of the student (at final exit).

**Cumulative Grade Card**

The grade card showing detail grades secured by the student in each subject in all semesters along with overall CGPA will be issued by the University at final exit.

# Semester - I

**Semester I (Core and Foundation Courses)**

**ELET – 111: Electronic Devices** **(04 credits)**

**Course Objectives:**

1. To introduce students to operation of FET, MOSFET, Opamps, oscillators and converters
2. TO make them understand biasing and amplification as well as linear and non-linear applications of opamp
3. To enable students to design and construct filters and converters

**Course Outcomes:**

After completion of the course students will be able to -

1. Apply the basic concepts in Analog electronics to solve the complex problems in electronic circuits
2. Analyse datasheets and circuit diagrams and identify circuits locks such as Op-amps Amplifiers filters
3. Design an electronic circuits using Op-amp and FET's
4. Design and develop a low cost prototype electronic circuit to address frequently occurring issues in Industries

**Course Contents:**

**Unit - I: Field Effect Transistors (Biasing and Amplifiers)** **(12 Hrs.)**

Introduction to FET biasing, Biasing configuration (Fixed Bias, Self-bias, Voltage divider bias, Common gate bias), D & E type MOSFET biasing, combination networks, universal J-FET bias curve, application

Introduction to FET amplifier, JFET small signal model, various configuration, (Fixed bias, self-bias, Voltage Divider, Common gate, Common drain), D & E type MOSFET, Voltage Divider configuration of D & E type MOSFET, Designing FET amplifier network, Application.

**Unit - II: Special Operational Amplifier, OP-AMP Application and Non-linear Function Circuits** **(12 Hrs.)**

High Voltage/high current amplifiers, chopper and choppers stabilized amplifier, instrumentation amplifier, isolation amplifier, bridge amplifier, Application.

Op-Amp application – DC voltmeters, V-I converter with floating load, LED Tester, Furnishing constant current to grounded load, short current measurement and I-V Conversion, Measurement of photoconductor current, current amplifier, Phase shifter, temperature to voltage converter

Nonlinear function circuit: limiters, 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, set-point controller, window detector), true RM/DC converter.

**Unit - III: Oscillators, Signal Generator, 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 synthesizers, Application, Concept of free running and one shot configuration, triangular wave generator, saw tooth wave generator, balanced modulator/demodulator, Universal trigonometric function generator (AD639), Precision sine/square wave generator, application, Timing and counting circuits: digital counters, shift register, analog and digital timers, frequency counters, PLA and PLD 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, Application Active filter types, Filter approximations – Butterworth and Chebyshev, filter realizations, frequency and impedance, scaling, filter transformations, sensitivity, switched capacitor circuit, application.

**Unit - V:** Presentations, Case studies, Assignments, Tutorials based on Module I to IV **(12 Hrs.)**

**References:**


1. Sende, B. S. – Introduction to System design using Integrated Circuits, New Age International (P), New Delhi.
2. Fitchen, F. C. – Integrated Circuits and Systems, Van Nostrand, New York.
3. Robert S. Coughlin, Frederick F. Driscoll- Operational Amplifiers and Linear Integrated Circuits; Prentice Hall of India, New Delhi
4. Ramakant A Gaikwad; 2000; OP-AMP and Liner Integrated Circuits ( Fourth Edition); PHI Learning PVT LTD; Delhi (India)
5. Boylestad R. L., Nashelsky L. – Electronic Devices and Circuit Theory, Pearson Education, New Delhi

## ELET – 112: Industrial Electronics (04 credits)

**Course Objectives:**

1. To introduce students to power electronics components
2. To understand them the operating characteristics of these power devices
3. To enable students to design triggering ON-OFF circuits

**Course Outcomes:**

After completion of the course students will be able to -

a) Apply principles of SCR, Power MOSFET, IGBT, and UJT for various Industrial applications.
b) Design a single phase, three phase full wave and half wave rectifier circuits.
c) Analyse the complex problems in power electronic circuits providing solution to problem.
d) Develop a prototype based power electronic circuits showing the best solution towards a particular problem.

**Course Contents:**

**Unit - I: Thyristor and related power Devices (12 Hrs.)**

Thyristor fundamentals, Structure of thyristor, Principal of operation of SCR, Static anode cathode characteristics, Gate circuit parameter, Turn-On method of thyristor, Dynamic turn on switching characteristics, turn-off mechanism, TRIAC: the triac, triac firing circuit, Power MOSFET: 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: Introduction, PUT relaxation oscillator.

**Unit - II: Gate Triggering Circuits (12 Hrs.)**

Introduction, firing of thyristor, pulse transformer, optical isolator, gate triggering circuit, resistance firing circuit, resistance capacitance firing circuit, resistance capacitor full-wave trigger circuit, UJT as an SCR trigger, synchronized triggering (ramp triggering), Phase controlled 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 half wave controlled rectifier: with Resistive load, with inductive load, Effect of freewheeling diode. Fully controlled bridge rectifier: with Resistive load, with resistive inductive load. With Resistive load, with inductive load, Effect of freewheeling diode

**Unit - IV: Inverters and Choppers (12 Hrs.)**

Inverters: Introduction, Tyristor inverters Classification, Series inverters: Basic Series inverters, Modified Series inverters, Three Phase Series inverters, High frequency Series inverters, Self-commuted inverters. Parallel

inverters: Basic Parallel inverters, Parallel inverters with feedback diodes. Choppers: Introduction, Principle of chopper operation, controlled stratifies, Step Up and Step down Chopper.

**Unit - V:** Presentations, Case studies, Assignments, Tutorials based on Module I to IV **(12 Hrs.)**

**References:**


1. Power Electronics - M. D. Singh, K. Khanchandani, (TMH) 2004, ISBN0-07463369-4
2. Power Electronics, M. S. Jamil Asghar, PHI, 2006, ISBN: 81-203-23963.
3. Principles of Electronics- V. K. Mehta, Rohit Mehta; S. Chand and company Ltd. 2012 ISBN: 81-219-2450-2.
4. Power Electronics - Dr. P. S. Bhimbra, Khanna Publishers, Fifth Edition, 2014 Reprint, New Delhi
5. Electrical circuit and Basic Semiconductor Electronics, Pragati Prakashan Meerut, 2010, ISBN: 978-93-5006-302-6
6. Industrial Electronics, S. N.Biswas, Dhanpati rai and Sons, 1996.

## ELET – 113: Sensor Fundamentals (04 credits)

**Course Objectives:**

1. To facilitate the students to understand
   a) the concepts of sensor
   b) the concept of different principles of sensors
2. To provide an opportunity to the students to enter into sensor research
3. To create enthusiasm among the students to undertake research in sensors

**Course Outcome:**

Students will be able to -

1. understand and explain Sensors, characteristics of sensors, optical fiber and optical sensors.
2. analyze the system based on sensor and actuators.
3. design and develop sensor devices
4. Students will be capable to undertake research in Sensors.

**Course Contents:**

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

Sensors and Sensor Science, Sensors – Eyes and Ears of Machines, The Term 'Sensor', Optical Sensors, Physical Sensors, Chemical Sensors, elements of chemical sensors, **Sensor Physics**, Solids, Energy Band Model, Lattice Defects, Ionic Conductance, Hopping, Junctions and Potential Barriers, **Primary electronics for sensors :** Amplification by Operational Amplifier, Instruments for electric measurements.

**Unit - II: Sensors and Sensor Characteristics (12 Hrs.)**

Sensors, Signals, and Systems; Ideal sensor curve, ideal sensor requisite, Sensor Classifications; **Sensor Characteristics**: Transfer Function; Span (Full-Scale Input); Full-Scale Output; Accuracy; Calibration; Calibration Error; Hysteresis; Nonlinearity; Saturation ; Repeatability; Dead Band; Resolution; **Parameters of sensors**: Sensitivity, detection limit, response and recovery time, selectivity, dynamic range, linearity, stability

**Unit - III: Optical Sensors (12 Hrs.)**

Introduction of light detectors: Photodiodes, Phototransistor, Photoresistors; photovoltaic cell, Optical waveguides and fibres, types of optical fibers: single mode, multimode and graded index optical fiber, concept of TIR and ATR, Optical fibre sensors: Introduction and classification of sensors with optical fibres, Optical fibre sensors with amplitude modulation, Sensor with wavelength modulation; Optical chemical sensors: Introduction, Optical sensors: Methods of detection, Evanescent wave sensors.

**Unit - IV: Physical Sensors (12 Hrs.)**

Potentiometric Sensors; Gravitational Sensors; LVDT and RVDT, Eddy Current Sensors, Piezoelectric sensors, **Resistive Sensors:** Potentiometers, Strain gauges; Inductive sensors, Capacitive sensors, Bridge circuits, Displacement Measurements, **Blood Pressure Measurements:** Extravascular sensors, Intravascular sensors, Disposable pressure sensors

**Unit - V:** Presentations, Case studies, Assignments, Tutorials based on Module I to IV **(12 Hrs.)**

**References:**


1. Chemical Sensors: An Introduction for Scientists and Engineers : Grundler, Peter; Springer Berlin Heidelberg New York **(2007),** ISBN 978-3-540-45742-8
2. Modern Sensors Handbook, Edited by Pavel Ripka and Alois Tipek; ISTE Ltd, USA **(2007),** ISBN 978-1-905209-66-8.
3. Handbook of Chemical and Biological Sensors; Edited by Richard F Taylor, Arthur D Little Inc., Jerome S Schultz, University of Pittsburgh ; Institute of Physics Publishing Bristol and Philadelphia; **( 1996)** ISBN 0 7503 0323 9
4. Hand Book of Modern Sensors : Physics, Designs and Applications By Jacob Fraden Third Edition (Springer-Verlag New York, Inc.) **(2004)**, ISBN 0-387-00750-4.
5. Understanding Smart Sensors By Randy Frank; Second Edition; Artech House Boston . London **(2000),** ISBN 1-58053-398-1.
6. Sensors and Transducers, Third Edition By Ian R. Sinclair; Butterworth-Heinemann publication, Woburn **(2001),** ISBN 0 7506 4932 1
7. Principles of Chemical Sensors : Janata, Jiri 2nd Edition ; Springer Dordrecht Heidelberg London, New York **(2009),** ISBN 978-0-387-69930-1 e-ISBN 978-0-387-69931-8
8. Optoelectronics Devices and System SECOND EDITION by S. C. Gupta; Prentice Hall International **(2011)** ISBN: 978-81-203-5065-6
9. Optical Fibers and fiber optic communication Systems by Subir Kumar Sarkar; S Chand & Company Ltd **(2000),** ISBN: 9788121914598
10. Lasers and Optical Fiber Communications by P Sarah; I.K. International Publishing House Pvt Ltd, New Delhi **(2008),** ISBN : 9788189866587 / 8189866583
11. Optoelectronics by R. A. Barapate ( Tech-Max Publication) **(2003 )**

## ELET – 114: Network Analysis and Synthesis (04 credits)

**Course Objectives:**

To equip the students with rigorous theoretical and practical knowledge to analyse and synthesize networks.

**Course Outcomes:**

- Apply the knowledge of basic circuital law and simplify the network using reduction technique.
- Analyze the circuit using Kirchoff's law and network theorem.
- Infer and evaluate transient response, steady state response, network functions.
- Equip with network synthesis study.

**Course Contents:**

**Unit - I: Network Theorems (08 Hrs.)**

Applications of Thevenin and Norton's theorem, Reciprocity theorem, Compensation theorem, Superposition theorem & Tellegen's theorem.

**Unit - II: Time Domain Analysis of Networks (16 Hrs.)**

Differential equation approach (first and higher order differential equations), initial conditions in networks, Laplace Transformation: Introduction to the Laplace transform approach, partial fraction expansion, Heaviside's expansion theorem, transform impedance and transform circuits, network functions, poles and zeroes of network functions and restrictions on pole and zero locations for driving-point functions and transfer function, stability of active network .

**Unit - III: Two Port Network Parameters (14 Hrs.)**

Transmission and inverse transmission parameters, hybrid and inverse hybrid parameters, relation between parameter sets, and interconnection of two port network, Graph Theory: graph tree, link branches, basic tie and cut set, matrices for planar networks, loop and nodal method of analysis

**Unit - IV: Network Synthesis (10 Hrs.)**

Properties of Hurwitz polynomial and positive real function, synthesis of LC, RC and RL network, Foster form and Cauer form.

**Unit - V:** Presentations, Case studies, Assignments, Tutorials based on Module I to IV **(12 Hrs.)**

**References:**

1. M. E. Van Valkenburg, "Network Analysis", 3rd ed., Pearson.
2. M. E. Van Valkenburg, "Network Synthesis", PHI.
3. DeCarlo, R. A. and Lin, P. M., "Linear Circuit Analysis: Time Domain, Phasor and Laplace Transform Approaches", Oxford University Press.
4. Hayt, Kemmerley and Durbin, "Engineering Circuit Analysis", 8th Ed. Tata McGraw-Hill.
5. Kuo, F. F., "Network Analysis and Synthesis", 2nd Ed., Wiley India.

## ELET – 115: Research Methodology (02 credits)

**Course Objectives:**

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

**Course Outcomes:**

Students will be able to -

1. understand and explain research process
2. do systematic literature survey, formulation of a research topic, study design, analysis and interpretation of data.
3. to design a research approach for a specific research issue of their choice.
4. select a suitable analytical method for a specific research approach.
5. demonstrate a good understanding of how to write a research report.
6. critically assess published quantitative research with regard to the statistical methods and approaches adopted
7. create a research document for implementation research project

**Course Contents:**

**Unit - I: Research Fundamentals: (05 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 (06 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, Case Studies

**Unit - III: Formulation of Research Problem (07 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 in decision making, Case Studies.

**Unit - IV: Research Report and Proposal Writing** **(06 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, Case Studies.

**Unit - V:** Presentations, case studies, Assignments, Tutorials based on Module I to IV **(06 Hrs.)**

**References:**


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.YavuzOruc; CRC Press, Taylor & Francis group **(2011),** ISBN: 9781439869185

**ELEL – 121: Lab Course 1 (Based on ELET-111 and ELET-112) (02 Credits)**

**List of Experiments:**

**I. Section A: based on ELET-111: Electronic Devices**

1. Study of Instrumentation amplifier
2. Study of window comparator
3. Study of Phase shift/ Wien bridge oscillator
4. Study of voltage controlled oscillator
5. Study of typical monolithic frequency synthesizer
6. Study of PLI
7. Study of digital counters (any two types, pertinent to topic taught in theory)
8. Study of I-V and V-I converter
9. Study of comparator Zero crossing with hysteresis

**II. Section B: based on ELET-112: Industrial Electronics**

1. Study of DC characteristics of SCR.
2. Study of firing circuits for SCR (any one type)
3. Study of DIAC
4. Study of TRIAC
5. Study of effect of variation of RC in R and RC triggering circuit on firing angle and output voltage of SCR
6. Study of the output waveform of single phase full wave controller rectifier with R and RL load, freewheel diode and measure load voltage
7. Study of effect of firing angle on output voltage in DIAC – TRIAC phase controlled
8. Study of Step UP chopper (with SCR/MOSFET/Transistor)
9. Study of Step down chopper (with SCR/MOSFET/Transistor)

**(Student should complete at least 04 experiments from each section)**

## ELEL – 122: Lab Course 2 (Based on ELET-113 and ELET-114)

**List of experiments:**

### I. Section A: based on ELET-113: Sensor Fundamentals

1. Determination of Numerical Aperture of PMMA optical fiber
2. Losses in Optical fiber.
3. Study of Optical to Electrical (O-E) characteristics of fiber optic Phototransistor converter.
4. Study of Electrical to Optical (E-O) characteristics of fiber optic 660nm an 850nm converter.
5. Optical fiber chemical sensor.
6. Study of Potentiometric sensor
7. Study of Displacement sensor
8. Gas sensor based on OCP (organic Conducting Polymers)
9. Gas Sensor based on Single Walled carbon nanotubes ( SWNTs)
10. Study of LVDT as displacement Sensor
11. Study of Hall Effect sensor as an event counter

### II. Section B: based on ELET-114: Network Analysis and Synthesis

1. Study of Thevenin's theorem
2. Study of Norton's theorem
3. Study of maximum power transfer theorem
4. Design and construct first order low pass and high pass RC filter
5. Design and construct second order low pass and high pass RC filter
6. Design and construct second order butterworth filter
7. Phase and frequency response from transfer function of a CT system: Low Pass and High Pass
8. Phase and frequency response from transfer function of a DT system: Low Pass and High Pass
9. Transient and steady state response of CT system: LCR series circuit with different inputs
10. Simulation of transfer function using poles and zeros
11. Synthesis of periodic waveform from Fourier coefficients

(Experiments 7 to 11 can be performed using PSPICE/MATLAB/C programming)

**(Student should complete at least 04 experiments from each section)**

**ELER – 131: Research Project Part - I (02 Credits)**
**(Review of Literature and Formulation of Topic for Research Project)**

Students are expected to do the following activities:

1) Selection of Broad topic for Research Project
2) Understanding fundamentals of the proposed broad topic
3) Identification of at least 10 best journals (Scopus Indexed) in the proposed topic
4) Literature review of at least 10 Research papers related to the proposed broad topic
5) Fine tuning of the research topic
6) Formulation of Hypothesis, Objectives and Methodology

Preparation of report in the following format

- Title of Research Project
- Introduction
- Survey of Literature
  - National / International Status
  - Gaps in the Existing research at National / International Level
- Hypothesis
- Objectives
- Methodology
- Expected Outcome
- Plan of Work (Time schedule of activity)
- References

# Semester - II

**Semester II (Foundation and Generic Elective Courses)**

**ELET – 211: 8086 Microprocessor and Interfacing (04 Credits)**

**Course Objectives:**

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

**Course Outcome:**

Students will be able to –

1. understand and explain Microprocessor architecture, physical configuration of memory, logical configuration of memory, microprocessor programming and interfacing.
2. analyze the process of Industrial automation
3. design automation system process of using 8086 microprocessor
4. start his / her own small scale industry for manufacturing microprocessor based automated devices.
5. start his / her teaching career either in science or engineering colleges / institutes as this course is included in science as well as 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, immediate addition, memory to register addition, array addition, increment addition, addition with carry; **Subtraction:** Register subtraction, immediate subtraction, decrement subtraction, subtraction with barrow; **Comparison, Multiplication**

**and division**: **Multiplication**: 8 bit multiplication, 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, right shift; **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 Control and 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 and Hall 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:** Presentations, Case studies, Assignments, Tutorials based on Module I to IV **(12 Hrs.)**

**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 – 212: Embedded System and Interfacing (04 Credits)

**Course Objectives:**

Students will facilitate to –

1. understand and explain microcontroller architecture, programming and interfacing
2. analyze the process of industrial automation and design automation system using microcontroller
3. provide an opportunity to the students to enter into entrepreneurship

**Course outcomes:**

After completion of the course students will be able to -

1. Design and develop automated system based on 8051 Microcontroller
2. Apply the basics of number system to solve arithmetic and logical operations of 8051 microcontroller.
3. Develop assembly language programming for 8051 microcontroller.
4. Analyse and debug assembly language programme for 8051 microcontroller
5. Interface I/O devices

**Course contents:**

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

An introduction: microprocessors and microcontrollers, comparing microprocessors and microcontrollers, a microcontrollers survey, development system for microcontrollers, 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/ output, interrupts.

**Unit - II: Moving data and logical operations (12 Hrs.)**

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

**Unit - III: Arithmetic operations, Jump and call instruction (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; Introduction, to the jump and call program range, relative range, short absolute range, long absolute range, jumps, but jumps, byte jumps, unconditional jumps, calls and subroutine, subroutines, calls and the stacks, calls and returns, interrupts and returns, examples problems.

**Unit - IV: 8051 Interfacing (12 Hrs.)**

Interfacing 8051 microcontroller to simple switch, LED, 7-segment display, DAC, ADC, LCD, matrix keyboard and Stepper motor as well as their Assembly language programming

**Unit - V:** Presentation, Case studies, Assignments, tutorials based on Module I to IV **(12 Hrs.)**

**References:**


1. Mazidi M. A., Mazid J. G. I and McKinlay R. D- The 8051 microcontroller and embedded system – Pearson, 2nd edition 2013
2. 8051 architecture, programming and interfacing K. J. Ayala; pen ram 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 - 213: Generic Elective - I (04 Credits)

### i. Properties of Electronic Materials

**Course Objectives:**

1. To make students to understand basic phenomenon as conductivity, reflection and absorption
2. To introduce students to electrical, dielectric, optical and magnetic properties of metal oxides and polymers

**Course Outcomes:**

After completion of the course students will be able to -

1. Understand basic phenomenon as conductivity, reflection and absorption
2. Understand electrical, dielectric, optical and magnetic properties of materials
3. Analyze the order of magnetic materials
4. Screen the wide range of materials for desired application
5. Enable to understand the defects in crystals and their effects on various properties

**Course Contents:**

**Unit - I: Electrical Properties of Metals (05 Hrs.)**

Conductivity, reflection and absorption, Fermi surfaces, superconductivity, thermoelectric phenomena, Conduction in metals oxides, amorphous materials

**Unit - II: Dielectric Properties of Materials (06 Hrs.)**

Macroscopic electric field, local electric field at anatom, dielectric constant and polarizability, ferroelectricity, antiferroelectricity, phase transition, piezoelectricity, ferroelasticity, electrostriction.

**Unit - III: Optical Properties of Materials (15 Hrs.)**

Optical constants and their physical significance, Kramers – Kronig Relations, Electronic inter bond and intra bond transitions, Relations between Optical properties and band structure – colour of material (Frenkel Excitons), Bond Structure determination from optical spectra reflection, refraction, diffraction, scattering, dispersion, photoluminescence, Electroluminiscence.

**Unit - IV: Magnetic Properties of Materials (22 Hrs.)**

Dimagnetism, paramagnetism, various contributions to para and dia magnetism, Adia-batic demagnetization, Paramagnetic susceptibility; Ferromagnetism, ferrimagnetism, ferrites, antiferromagnetism, Curie point, temperature dependence of saturation magnetization, saturation magnetization at absolute zero, magnons and their thermal excitation, dispersion relation, Neutron Magnetic scattering, Ferrimagnetic and antiferrimagnetic order, domains and domain walls, magnetic resonance. Coercive force, hysterisis, methods for parameters measurements

**Polymers:** Structure of polymers, polymerization mechanism, characterization techniques, optical, electrical, thermal and dielectric properties of polymers.

Defects in crystals and their effects on mechanical, electrical and optical properties; Diffusion in materials

**Unit - V:** Presentation, Case studies, Assignments, tutorials based on Module I to IV **(12 Hrs.)**

**References:**


1. Electronic Properties of materials, R. E. Hummel Springer New York publication
2. Solid State Physics, Dekkar, Mcgraw Higher Ed publication
3. Introduction to Solid State Physics, C. Kittle, Wiley publication
4. Solid State Physics, Ashcroft, Mermin,Cengage Learning Publication
5. Principles of Electronic materials & dev, S. O. Kasap, Mcgraw Higher Ed Publication
6. Elementary Solid state physics, M. Ali Omar; Pearson Publication.

**ELET - 213: Generic Elective - I** **(04 Credits)**

**ii. Control Systems**

**Course Objectives:**

1. To introduce students to the classifications of control system, controllers and complex modes of operation
2. To make students understand the advantages and limitations of various types of control systems

**Course Outcomes:**

1. Acquire terminologies in control system.
2. Design Control system by block diagram & Signal flow graph.
3. Estimate the stability of control system.
4. Apply different tuning method according to control operation.

**Course Contents:**

**Unit - I: Element of control system** **(12 Hrs.)**

Classification of control System, operational amplifier as error detector, servomechanism, Transfer function and impulse response function, Automatic control system. Block Diagram algebra; block diagram fundamentals, Canonical or simple form of control system, Block Diagram reduction rules. Signal flow graphs; signal flow graphs terms, properties of SFG, Mason's gain equation, use of mason's gain formula for electrical network.

**Unit - II: Control System analysis** **(12 Hrs.)**

Transient and steady-state response analysis; first order system, second order system & higher order system. Routh's stability criterion, Root locus plots, Lead compensation & lag compensation, lead-lag compensation, Bode diagrams, Nyquist stability criterion.

**Unit - III: Mathematical modeling of control system** **(12 Hrs.)**

Mathematical modeling of control system; Mechanical system, Electrical system, liquid level system, pneumatic system, Hydraulic system, Thermal system. Interacting and non interacting system; Step response of single capacity system, Step response of first order systems arranged in non-interacting mode, impulse response of first order systems arranged in non-interacting mode, Step response of first order systems arranged in interacting mode, Impulse response of first order systems arranged in interacting mode.

**Unit - IV: Control loop tuning** **(12 Hrs.)**

Ziegler-Nichols method for tuning of PID controller, Control cascade loops, feedback & feed forward control nonlinear & Adaptive control, Ratio control, Relative gain calculations, selective,

override & limit controls.

**Unit - V:** Tutorials, Assignments, Demonstrations and Presentation based on Module I to IV **(12 Hrs.)**

**References:**
**Text:**


1. Katsuhiko Ogata; 2010; Modern Control Engineering (Fifth Edition); PHI Learning PVT LTD; Delhi (India)
2. Bela G. Liptak; Process control (Third Edition), Instrument Engineer's Handbook.
3. Farid Golnaraghi, Benjamin c. Kuo; 2009; automatic control system; John Wiley & sons, inc.
4. Interacting and non-interacting system; https://www.apexinnovations.co.in.
5. N. Barapate; 2006; Control System; Tech Max publications; Pune (India)


**Suggested Reading:**


1. I. J. Nagrath, M. Gopal; 2009; Control Systems Engineering (Fifth Edition); New Age International Publishers; India
2. Norman S. Nise; 2004;Control system engineering(Fourth edition);Wiley international edition
3. A. Nagoorkani; 2006; Control System; RBA publications; Chennai (India)
4. K. Ogata; 2002; Modern Control Engineering; Prentice Hall; New Delhi(India)
5. Richard Dorf , Robert Bishop; 2005; Modern Control System; Pearson Education ; New Jersey

**ELET - 213: Generic Elective - I** **(04 Credits)**

**iii. Signal Conditioning Circuits**

**Course Objectives:**

1. To introduce students to understand both analog and digital signal conditioning
2. To make students able to design the various electronic circuits
3. To enable students to signal condition output of various types of sensors

**Course Outcomes:**

After completion of the course students will be able to -

1. Describe the type of signal conditioning & its importance in electronic circuits.
2. Evaluate various terminologies used signal conditioning circuit.
3. Assess signal conditioning for specific applications.
4. Design and developed a signal conditioning circuit for resistive, inductive and capacitive sensors.

**Course Contents:**

**Unit - I: Principles of analog and digital signal conditioning** **(12 Hrs.)**

Introduction, signal level and bias changes, linearization, conversation faltering and impedance matching, concept of loading, divider circuits, bridge circuits, lead compensation, RC filters (low pass, high pass), Readout/ meter. Introduction, application of Boolean algebra, Converters (comparators, DAC, ADC), Readout/display

**Unit - II: signal conditioning for resistive sensors** **(12 Hrs.)**

Temperature sensor (RTD, Thermistor), load cell, potentiometric sensors, Basic characteristics (principle, linearity, range, power rating and losses), excitation techniques (constant power, current, bridge), detectors and converters (resistance to Current, resistance to voltage, resistance to frequency, resistance to time)

**Unit - III: signal conditioning for capacitive sensors** **(12 Hrs.)**

Level sensor, displacement sensor, proximity detector, humidity sensor, differential pressure cell, Basic characteristics (principle, linearity, and range), excitation techniques (constant voltage/current, bridge), detectors and converters (impedance matching, capacitance to frequency, capacitance to time, capacitance to voltage)

**Unit - IV: signal conditioning for inductive sensors** **(12 Hrs.)**

Displacement transducer (LVDT/RVDT), proximity detector, inductive pick-up, Basic Characteristics (principle, linearity, and range), excitation techniques, detectors and converters (phase sensitive detector/rectifier, wave shaper)

**Unit- V:** Presentation, Case Studies, Assignments, Tutorial based on Module I to IV **(12 Hrs.)**

**References:**


1. Paul Horowitz, Winfield Hill, "The Art of Electronics", 2nd Ed., Cambridge University press, 2008.
2. Andrew Parr, " Industrial Control hand book", 3rd ed., Newnes Industrial Press, 2000
3. Walt Kester, " Practical Design Techniques for Sensor Signal" Analog Devices, Inc.,1999
4. John G. Webster, "Sensors and signal conditioning" 2nd ed. Wiley-Inter science Publication, 2001.
5. Curtis D. Johnson, " Process control instrumentation technology" 8th ed. PHI learning Pvt. Ltd., 2010
6. Thomas G. Beckwith, John H. Lienhard V, Roy D. Marangoni, "Mechanical measurements" 6th ed., Pearson Prentice Hall, 2012.
7. Andrew Parr, " Industrial Control hand book", 3rd ed., Newnes Industrial Press, 2000

## ELET – 214: Generic Elective - II (04 Credits)

### i. Advanced Sensor Technology

**Course Objectives:**

1. To introduce materials and their requisite in the perspectives of sensor
2. To make understand the operation of principles of various sensors
3. To make students facilitate manufacturing techniques for sensors
4. To enable students to fabricate sensors through various technologies

**Course Outcome:**

After completion of the course students will be able to –

1. Classify sensor materials and technologies.
2. Analyze the system based on sensor and actuators.
3. Design experiments for sensor calibration
4. Develop sensor devices and sensor networks.
5. Design and develop sensor devices

**Course Contents:**

**Unit - I: Sensor Materials and Sensor Matrix (12 Hrs.)**

Materials: Material selection criteria, fulfillment of ideal sensor requisite, importance of 1-D materials in sensors, importance of surface area enhancement and enhancement in surface activity, Importance of size dependent Properties for sensing applications; Promising sensing materials: Carbon Nanotubes, Organic Conducting Polymers, Porphyrins and metal nanoparticles, Sensor Fabrication Technologies: AC Dielectrophoretic alignment of SWNTs and surface modification of SWNTs by OCP by charge controlled potentiostatic deposition and porphyrins by solid casting, for SWNTs, confirmation of coating by I-V measurements and electrochemical measurements;

**Unit - II: Chemical Sensors (12 Hrs.)**

Chemical Sensor Characteristics; Specific Difficulties; Classification of Chemical-Sensing Mechanisms; Direct Sensors: Metal-Oxide Chemical Sensors, Chemiresistive and ChemFET sensors, Electrochemical Sensors, Potentiometric Sensors, Conductometric Sensors, Amperometric Sensors, Complex Sensors: Optical Chemical Sensors Biosensor, Multisensor Arrays, Electronic Noses (Olfactory Sensors)

**Unit - III: Integrated circuit manufacturing techniques for Sensors (12 Hrs.)**

Introduction, Photolithography: Masks, Mask alignment, Spinning resist; Exposure and development: Exposure, Development, Resist tone, Critical dimension (CD) and resolution (R), Resist stripping: Wet stripping, Dry stripping; Subtractive techniques: Overview, Dry etching: Physical etching: sputtering or ion etching, Etching profiles for physical etching, Dry chemical

etching, Physical-chemical etching; Wet etching: Anisotropic and isotropic etching, Etch stop techniques, Comparison of dry- and wet-etch techniques;

**Unit - IV: Sensors Technology (Techniques for Sensor Fabrication) (12 Hrs.)**

Chemical Methods for preparation of sensor matrix: Chemical bath deposition, SILAR, Physical vapor deposition: Evaporation, Sputtering, Molecular beam epitaxy, Laser ablation deposition; Chemical vapor deposition: AP CVD and LP CVD, PE CVD, Spray pyrolysis; Electrodeposition and electroless deposition: Electroless deposition, Electrodeposition, Potentiostatic, Galvanostatic, Cyclic voltammetry: Chemical sensor fabrication technology: screen printing, spin coating, dip coating, and casting.

**Unit - V:** Presentation, Case Studies, Assignments, Tutorial based on Module I to IV **(12 Hrs.)**

**References:**


1. Modern Sensors Handbook, Editedby Pavel Ripka and AloisTipek; ISTE Ltd, USA **(2007)**, ISBN 978-1-905209-66-8.
2. Handbook of Chemical and Biological Sensors; Edited by Richard F Taylor, Arthur D Little Inc., Jerome S Schultz, University of Pittsburgh ; Institute of Physics Publishing Bristol and Philadelphia; **( 1996)** ISBN 0 7503 0323 9
3. Hand Book of Modern Sensors : Physics, Designs and Applications By Jacob Fraden Third Edition (Springer-Verlag New York, Inc.) **(2004)**, ISBN 0-387-00750-4.
4. Understanding Smart Sensors By Randy Frank; Second Edition; Artech House Boston. London **(2000),** ISBN 1-58053-398-1.
5. Sensors and Transducers, Third Edition By Ian R. Sinclair; Butterworth-Heinemann publication, Woburn **(2001),** ISBN 0 7506 4932 1
6. Chemical Sensors: An Introduction for Scientists and Engineers: Grundler, Peter; Springer Berlin Heidelberg New York **(2007),** ISBN 978-3-540-45742-8
7. Principles of Chemical Sensors : Janata, Jiri 2nd Edition ; Springer Dordrecht Heidelberg London, New York **(2009),** ISBN 978-0-387-69930-1 e-ISBN 978-0-387-69931-8
8. Optoelectronics Devices and System SECOND EDITION by S. C. Gupta; Prentice Hall International **(2011)** ISBN: 978-81-203-5065-6
9. Optical Fibers and fiber optic communication Systems by Subir Kumar Sarkar; S Chand & Company Ltd **(2000),** ISBN:9788121914598
10. Lasers and Optical Fiber Communications by P Sarah; I.K. International Publishing House Pvt Ltd, New Delhi **(2008),** ISBN : 9788189866587 / 8189866583
11. Optoelectronics by R. A. Barapate (Tech-Max Publication) **(2003 )**

## ELET – 214: Generic Elective - II (04 Credits)

### ii. Process Control and Instrumentation

**Course Objectives**

1. Introduce fundamentals of Distributed control system, their design and operation.
2. To make students understand control actions in industrial processes.

**Course Outcomes**

On completion of the Course, students should be able to-

1. Recall the basic PID control actions
2. Recognize elements of computer based distributed control system.
3. Describe the process control systems based on PLC.
4. Create process control drawings of different industrial processes

**Course Contents:**

**Unit - I: Control Action** **(12 Hrs.)**

Need for Process Control, Basic control action, Characteristics of ON-OFF, Proportional, Integral and Derivative Control Modes, Composite Control Modes, Electronic controllers to realize various control actions, Servo and regulator operation, Process control symbols.

**Unit - II: Automated Process Control** **(12 Hrs.)**

Introduction to Distributed control system (DCS), Elements of DCS, The control console equipment, Relay Rack mounted equipment, Communication between components, Generic features of DCS, Supervisory computer functions, Supervisory control & optimization, Production monitoring and control, On-line information system ,Supervisory control techniques and consideration.

**Unit - III: Process Control Systems** **(12 Hrs.)**

Process control drawings, Airhandler control, FAN controls, Temperature controls, Humidity controls, Process gains, Time lags, Reaction curves, Overview of the PID instructions in the ladder diagram, The PID instructions for the SLC500 or equivalent PLC module, Continuous and batch processes, batch processes & their automation (equipment for batch automation), Batch control function- Regulatory control, Discrete control, Sequential control

**Unit - IV: Industrial Processes** **(12 Hrs.)**

Surge–vessel level control loop, Temperature control loop, flow control loop, Air pressure control loop, control of CSTR, Temperature control of heat exchanger, Control of CSTR, Distillation(basic control), Distillation(Advanced controls),Control of distillation column, compressor control, compressor control, Control of adiabatic PFR, Blending and ratio control, Dryer control.

**Unit -V:** Presentations, Case studies, Assignments, Tutorials based on Module I to IV **(12 Hrs.)**

**References:**

**Text:**


1. D. P. Eckman – Automatic Process Control – Wiley Eastern Ltd., New Delhi, 1993
2. G. Stephanopoulis – Chemical Process Control- PHI, New Delhi, 1990
3. B. G. Liptak – Process Control – Chilton Book Company, 1994
4. C. D. Johnson – Process Control Instrumentation Technology – 7th edition, Pearson Education, New Delhi, 2002
5. J. G. Balchen, K. J. Mumme – Process Control Structures and Application – Van Nostrand Reinhold Co., New York, 1988
6. A.P.Kulkarni- Process instrumentation and control-NiraliPrakashan, April 2011.
7. Thomas E.Kissell-Industrial Electronics-3rd edition, PHI learning private limited, Newdehli,2012.


**Web:**


1. https://onlinecourses.nptel.ac.in/noc19_ch09/

**ELET – 214: Generic Elective - II** **(04 Credits)**

### iii. Biomedical Instrumentation - I

**Course Objectives:**

1. To make students understand the bio-potential generation
2. To introduce students with bipotential electrodes required for various measurements
3. To enable students to understand biopotential, biomechanical and biochemical measurements

**Course Outcomes:**

After completion of the course students will be able to –

a) Assess the importance of Biomedical instrumentation and its applications
b) Analyse the data obtained from various biomedical instruments
c) Apply the appropriate techniques used in biomedical field for specific applications.
d) Describe the EEG, EMG, techniques with all their relevant aspects.

**Course Contents:**

**Unit - I: Biopotential Electrodes** **(12 Hrs.)**

Origin of bio potential and its propagation Electrode-electrolyte interface, electrode – skin interface, half cell potential, impedance, polarization effects of electrode – nonpolarizable electrodes. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits, Recording problems - measurement with two electrodes

**Unit - II: Biopotential Measurement** **(12 Hrs.)**

Biosignal characteristics – frequency and amplitude ranges. ECG – Einthoven's triangle, standard 12 lead system, EEG – 10-20 electrode system, unipolar, bipolar and average mode, EMG– unipolar and bipolar mode. Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier – right leg driven ECG amplifier, Band pass filtering, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier. Power line interference

**Unit - III: Biomechanical Measurement** **(12 Hrs.)**

Temperature, respiration rate and pulse rate measurements. Blood Pressure: indirect methods - auscultatory method, oscillometric method, direct methods: electronic manometer, Pressure amplifiers - systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurement.

**Unit - IV: Biochemical Measurements** **(12Hrs.)**

Biochemical sensors - pH, $P_{O_2}$ and $P_{CO_2}$, Ion selective Field Effect Transistor (ISFET), Immunologically sensitive FET (IMFET), Blood glucose sensors - Blood gas analyzers,

colorimeter, flame photometer, spectrophotometer, blood cell counter, auto analyzer (simplified schematic description).

**Unit - V:** Presentation, Case Studies, Assignments, Tutorial based on Module I to IV **(12 Hrs.)**

**References:**


1. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2004.
2. John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2006
3. Leslie Cromwell, "Biomedical Instrumentation and measurement", Prentice hall of India, New Delhi, 2007.
4. Khandpur R. S., "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, New Delhi, 2003.
5. Myer Kutz Standard Handbook of Biomedical Engineering & Design – McGraw-Hill Publisher, 2003.

**ELEL – 221: Lab course 3 (based on ELET - 211 and ELET - 212)** **(02 Credits)**

**List of Experiments:**

**I. Section A: based on ELET - 211: 8086 Microprocessor and Interfacing**

1. Data transfer, addition, subtraction, multiplication, and division using 8086 trainer.
2. Factorial and square of the number using 8086 trainer.
3. Sorting of data (Ascending/Descending), obtaining square root of number using 8086 trainer kit.
4. Arithmetic mean of N numbers and sum of square of Numbers using 8086 trainer kit.
5. Interfacing of SPDT switches and seven segment display as a position encoder/decoder to 8086 trainer kit.
6. Interfacing of stepper motor with 8086 trainer kit.
7. Interfacing of DC motor with 8086 trainer kit.
8. Interfacing of DAC with 8086 trainer kit to generate ramp wave, triangular wave, and square wave.
9. Interfacing of 8 bit ADC with 8086 trainer kit.
10. Interfacing of LCD display with 8086 trainer kit.

**II. Section B: based on ELET - 212: Embedded System and Interfacing**

1. Data transfer, addition, subtraction, multiplication, and division using 8051 microcontroller trainer.
2. Sorting of data (Ascending/Descending), obtaining square root of number using 8051 trainer kit.
3. Program for temperature control interface using 8051 microcontroller.
4. Program to interface simple switch and LED using 8051 microcontroller
5. Program to interface an seven segment display using 8051 microcontroller
6. Program for analog to digital converter interfacing using 8051 microcontroller.
7. Program to generate ramp, square and triangular wave using DAC interfaced to 8051 microcontroller.
8. Program for interfacing stepper motor with 8051 microcontroller.
9. Program to interface an LCD using 8051 microcontroller
10. Program to interface matrix keyboard using 8051 microcontroller

**(Students should complete at least 04 experiments from each section)**

**ELEL – 222: Lab course 4 (based on ELET- 213 (i) and ELET- 214 (i))** **(02 Credits)**

**List of Experiments:**

**I. Section A: based on ELET - 213: (i) Properties of Electronic Materials**

1. Study of band gap of semiconductor using 4 probe method
2. Study the dielectric constant of solids as a function of temperature
3. Study of verification of the Curie law
4. Study of variation of resistivity of given specimen using 4-probe method and determination of its energy bandgap
5. Recording of spectra of given specimen using spectrophotometer
6. Polymerization and study of electrical (I/V) and optical properties of given polymer.
7. Study of reflectance, absorbance and transmission spectra of given specimen.
8. Determination of magnetic susceptibility of diamagnetic and paramagnetic samples using Guoy balance method
9. Study of variation of dielectric constant as a function of temperature and verification of the Curie law and determination of the Curie temperature
10. Study of variation of photoconductivity using polarized light

**II. Section B: based on ELET - 214: (i) Advanced Sensor Technology**

1. Study of characteristics of photovoltaic cell
2. Study of characteristics of Phototransistor.
3. Study of characteristics of Photoconductive cell
4. Study of characteristics of PIN Photodiode
5. Study of characteristics of IC temperature sensor (LM 335)
6. Study of K (chromel – alumel) type Thermocouple
7. Characteristics of Platinum RTD (Resistance – Temperature Detector)
8. Characteristics of NTC (negative Temperature Coefficient) Thermistor
9. Study of Optical fiber Pressure sensor
10. Gas sensor based on OCP (organic Conducting Polymers)
11. Gas Sensor based on Single Walled carbon nanotubes (SWNTs)

**(Students should complete at least 04 experiments from each section)**

**ELEL – 222: Lab course 4 (based on ELET - 213 (ii) and ELET - 214 (ii)) (02 Credits)**

**List of Experiments:**

**I. Section A: based on ELET 213: (ii) Control Systems**

1. Study of open loop system
2. Study of close loop system
3. Design a signal conditioning circuit for analog controller
4. Problem solving using root locus method
5. Study of lead compensator
6. Study of lag compensator
7. Study of lead-lag compensator
8. Study of Bode and Nyquist plot to determine loop system stability
9. Study of close loop control with PID controller
10. Study of PID controller tunning using Ziegler Nichols method

**II. Section B: based on ELET 214: (ii) Process Control Fundamentals**

1. Study of ON/OFF controller
2. Study of close loop system with disturbance.
3. Study of steady state error.
4. Study of proportional controller.
5. Study of integrator controller.
6. Study of Derivative controller.
7. Study of PI controller.
8. Study of PD controller.
9. Study of PID controller.
10. Study of PID controller in close loop.
11. Study of open loop speed control for PWM controller with and without load.
12. Study of ON/ OFF temperature controller.
13. Study of light intensity control system.

**(Students should complete at least 04 experiments from each section)**

**ELEL - 222: Lab course 4 (based on ELET - 213 (iii) and ELET - 214 (iii))** **(02 Credits)**

**List of experiments:**

**I. Section A: based on ELET 213: (iii) Signal Conditioning Circuits**

1. Design and implementation of electronic thermometer using PT100
2. Design and implementation of temperature indicator using thermocouple with cold junction compensation technique
3. Design and implementation of weighing machine using load cell
4. Design and implementation of liquid level indicator using electromechanical system.
5. Design and implementation of liquid level indicator using capacitive transducer.
6. Design and implementation of digital control logic for process using electronic hardware / software.
7. Demonstration and characterization of stroboscope.
8. Design and implementation of through beam/ reflected beam type optical proximity switch.
9. Design and implementation of signal conditioning scheme for position and/or direction detection for optical encoder.
10. Design and implementation of signal conditioning scheme for displacement measurement using LVDT.

**II. Section A: based on ELET 214: (iii) Biomedical Instrumentation - I**

1. Design of low noise pre-amplifier for ECG.
2. Study of effect of offset potential in Bio potential recording.
3. Study of effect of contact impedance in Bio potential recording.
4. Measurement of pulse-rate using Photo transducer.
5. Measurement of respiration rate.
6. Measurement of blood flow velocity using ultrasound transducer.
7. Measurement of heart rate using F-V converter.
8. Measurement of blood pressure
9. Measurement of oxygen concentration ($SpO_2$) variation of the blood by oxymeter
10. Determining random sugar contents in blood using digital glucometer

**(Students are expected to complete at least 04 experiments from each section)**

**ELER - 231: Research Project Part II** **(02 Credits)**

**(Experimental Work)**

Students are expected to do the followings;

a) Preparation of experimental plan as per the Objectives, Methodology finalized in the first semester
b) Experimental work based on the plan mentioned above

# Semester - III

**Semester III (Foundation and Generic Elective Courses)**

**ELET - 311: Programmable Logic Controllers (04 credits)**

**Course Objectives:**

1. To introduce students with programmable logic components and systems
2. To make students understand various instructions required for PLC
3. To enable students to program PLCs for various applications

**Course Outcomes:**

After completion of the course students will be able to –

a) Evaluate PLCs for various applications
b) Apply and explain basic concepts of ladder logic, its relationships with PLC instruction sets.
c) Develop a simple ladder logic program for timer and counter applications
d) Design a small prototype based production line using PLC

**Course Contents:**

**Unit - I: Programmable Logic Controllers (PLC)** **(12 Hrs.)**

Introduction to PLC, definition, PLC system and components of PLC input output module, advantages and disadvantages of PLC. Ladder diagram & PLC programming fundamentals: Basic components and other symbols, Fundamentals of ladder diagram, Difference between physical components and program components in PLC

**Unit - II: PLC Instructions** **(12 Hrs.)**

Bit Logic Instructions: NO, NC, Set, Reset, Falling Edge Pulse, rising edge Pulse RS, SR, NOP, OUTPUT. Clock: READ, RTC, SET_RTC. Logical operation Instructions: INVERT BIT, BYTE, WORD DOUBLE WORD. OR: BIT, BYTE, WORD DOUBLE WORD.AND: BIT, BYTE, WORD DOUBLE WORD.X-OR: BIT, BYTE, WORD DOUBLE WORD.

**Unit - III: PLC Programming** **(12 Hrs.)**

PLC input Instructions, outputs, coils, indicators, operational procedures, Contact and coil input output, programming example, fail safe circuits, Simple industrial applications. PLC Functions PLC timer functions Introduction, timer functions, industrial applications, industrial process Timing applications, PLC control functions –PLC counters and its industrial applications, nesting of ladders.

**Unit - IV: Applications of PLC** **(12 Hrs.)**

Interfacing Input and Output devices with PLC, Switches: Push button Switches, Toggle Switches, Proximity switches, Temperature Switch, Pressure Switch, and Level Switch, Flow Switches, manually operated switches, Motor starters, Transducers and sensors, Transmitters etc. Their

working, specification and interfacing with PLC.
Different types of Output devices: Electromagnetic Control Relays, Latching relays, Contactors, Motors, Pumps, Solenoid Valves etc. Their working, specification and interfacing with PLC.

**Unit - V:** Presentations, Case studies, Assignments, Tutorials based on Unit I to IV **(12 Hrs.)**

**References:**


1. John W. Webb, Ronold A Reis, "Programmable Logic Controllers, Principles and Applications"; 5th Edition, Prentice Hall of India Pvt. Ltd.
2. Programmable Logic Controllers Programming Method and Applications by JR.
3. Hackworth, "Programmable Logic Controller", 1st edition.
4. Frank Petruzella. D "Programmable Logic Controllers", Tata McGraw Hill
5. Bolton. W, "Programmable Logic Controllers" Fifth Edition, 2009.

## ELET – 312: Internet of Things (04 credits)

**Course Objectives:**

1. To introduce students to the concept of internet of things
2. To make them understand the things, protocols and IoT devices
3. To introduce students to the concept of industrial internet of things

**Course Outcomes:**

After completion of course, student will able to-

a. Analyse basic protocols in wireless sensor network
b. Explain architectural design for IoT for specific application
c. Choose between available technologies and devices for stated IoT challenge
d. Design and Implement IoT applications in different domain
e. Describe the concept of industrial internet of things

**Course Contents:**

**Unit - I: Introduction to Internet of Things (IoT)** **(12 Hrs.)**

Definition and characteristics of IoT, Internet of Things: Vision, Emerging Trends, Economic Significance, Technical Building Blocks, Physical design of IoT, Things of IoT, IoT Protocols, Logical design of IoT, IoT functional blocks, IoT communication models, IoT Communication APIs, IoT Issues and Challenges, Applications.

**Unit - II: IoT Protocols and Devices** **(12 Hrs.)**

Protocol Standardization for IoT, M2M and WSN Protocols, SCADA and RFID Protocols, BACNet Protocol, Modbus, KNX, Zigbee Architecture Network layer, Issues with IoT Standardization, MAC protocol survey, Survey routing protocols,

**IoT Devices :** IoT Physical Devices and Endpoints: Basic building blocks of and IoT device, **WSN**: The internet of transducer, **RFID**: The internet of objects, **M2M**: The internet of devices, **SCADA**: The internet of controllers.

**Unit - III: Design, Implementation and Application of IoT.** **(12 Hrs.)**

Introduction to different IoT tools, Developing applications through IoT tools, Implementing IoT concepts with Arduino/python, Home automation, Industry applications, Surveillance applications, Other IoT applications.

**Unit – IV: Basics of Industrial IoT** **(12 Hrs.)**

Introduction; IIoT vs Automation; Challenges in IIoT; Applications of IIoT: Healthcare industry, Mining industry, Manufacturing industry, Transportation & logistics, Firefighting; Industrial Internet System: Introduction; Three Waves of Innovation: The Industrial Revolution, The Internet Revolution, The Industrial Internet; Three Key Elements: Intelligent Machines, Advanced Analytics, People at Work; Applications of Industrial internet

**Unit - V:** Presentations, Case studies, Assignments, Tutorials based on Module I to IV **(12 Hrs.)**

**References:**


1. Al-Fuqahaet. al, "Internet of Things: A Survey on Enabling Technologies, Protocols, and Applications", IEEE Communication Surveys & Tutorials, Vol. 17, No. 4, 2015.
2. J. Biron and J. Follett, "Foundational Elements of an IoT Solution", O'Reilly Media, 2016.
3. Keysight Technologies, "The Internet of Things: Enabling Technologies and Solutions for Design and Test", Application Note, 2016.
4. Charles Bell, "Beginning Sensor Networks with Arduino and Raspberry Pi", Apress, 2013.

## ELET - 313: Generic Elective - III (04 credits)

### i. Fabrication Techniques for Electronic Devices

**Course Objectives**

1. To introduce students to semiconductor materials and its fabrication techniques
2. To make them understand various processes such as oxidation, photolithorgraphy, etching, diffusion etc in the process of fabrication

**Course Outcomes:**

1. Apply the basic knowledge in Microelectronic fabrication technique
2. Know the fundamental challenges in fabrication technique
3. Differentiate and analyze tradeoffs in processing parameters to optimize process parameters
4. Design and develop mask level silicon based device.

**Course Contents:**

**Unit - I: Introduction to Semiconductor material and Fabrication Techniques (12 Hrs.)**

Semiconductor materials, semiconductor devices, basic fabrication steps, oxidation, photolithography and etching, diffusion and ion implantation, metallization, silicon crystal growth from the Melt, Silicon Float Zone process, GaAs Crystal growth technique, material characterization, wafer shaping, crystal characterization.

**Unit - II: Silicon Oxidation and Photolithography (12 Hrs.)**

Thermal oxidation process, impurity redistribution during oxidation, masking properties of silicon dioxide, oxide thickness characterization, Basics of Photolithography, optical lithography- The clean room, Exposure tools, mask, photoresist, pattern transfer, resolution enhancement, Next generation lithographic methods, Electron beam lithography, extreme ultraviolet lithography, X-Ray lithography, Ion beam lithography

**Unit - III: Etching and Diffusion (12 Hrs.)**

Wet chemical etching- silicon etching, silicon dioxide etching, silicon nitride and polysilicon etching, aluminum etching, gallium arsenide etching, Dry etching-plasma Fundamentals, Reactive plasma Etching, Aluminum Basic diffusion process, diffusion equation, diffusion profiles, evaluation of diffused layers, extrinsic diffusion, lateral diffusion.

**Unit - IV: Ion Implantation and Film Deposition (12 Hrs.)**

Range of implanted ions, ion distribution, ion stopping, ion channeling, implant damage and annealing, implanted related processes- multiple implantation and masking, tilt angle implantation, high energy and high current implantation, Film Deposition- Epitaxial growth techniques,

chemical vapor deposition, molecular beam epitaxy, structures and defects in epitaxial layers, dielectric deposition, metallization.

**Unit - V:** Presentations, Case studies, Assignments, Tutorials based on Module I to IV **(12 Hrs.)**

**References:**


1. GARY S May, Simon .M. Sze "Fundamental of Fabrication", ISBN 0-471-23279-3.
2. S.M. Sze (2nd Edition) "VLSI Technology", McGraw Hill companies Inc.
3. Stephen, Campbell, "The science and Engineering of Microbalance Fabrication", second Edition, Oxford University Press.
4. James D. Plummer, Michel D. Deal, "Silicon VLSI Technology" Pearson Education.

## ELET - 313: Generic Elective - III (04 credits)

### ii. Instrumentation in Process Control

**Course Objectives:**

To introduce students to the multifaceted challenges in industrial process measurements and advanced field instrumentation

**Course Outcomes:**

On completion of the Course, students should be able to-

1. Explain basic building block of instrumentation systems
2. Recognize challenges in process variable monitoring and measurements
3. Describe operation of application specific instrumentation for temperature, level, pressure and flow
4. Describe operation of special application sensors especially for safety applications

**Course Contents:**

**Unit - I: Introduction of Instrumentation (10 Hrs.)**

**Introduction of Instrumentation:** Block diagram of Instrumentation, Transducer, Classification of Transducers, Parameter of Electrical Transducer, Sensor, Characteristics of sensor, Selection of sensor, **Basic Sensors:** Displacement, Location and Position Sensor: Resistive, capacitive and inductive sensor, LVDT, RVDT. Strain sensor: strain and stress, strain gauge sensor, metal strain gauge, semiconductor strain gauge. Motion sensor, Proximity sensor, Encoder-Incremental, Rotary

**Unit - II: Process Variable Measurement-Temperature and Level (14 Hrs.)**

**Temperature Measurement:** Bimetallic Thermometer, Calibration and Simulators, Fiber Optic Thermometer, Filled-Bulb and Glass-Stem Thermometer, Integrated Circuits (IC) Transistors and Diodes, Miscellaneous Temperature Sensor, Pyrometric Cones, Radiation and Infrared Pyrometers, Temperature Switches and Thermostats, Thermo wells, Ultrasonic Thermometers, Applications and Selection.

**Level Measurement:** Capacitance and Radio Frequency (RF) Admittance Probes, Conductivity and Field Effect Level Switches, Diaphragm Level Detector, Differential Pressure Level Detector, Displacer level detector, Float level devices, Laser level sensor, Microwave level switch, Optical level devices, RADAR level transmitter and Gauges, Radiation level sensor, Thermal level sensor, Vibrating level switch, Application and selection

**Unit - III: Process Variable Measurement-Flow and Pressure (13 Hrs.)**

**Flow Measurement:** BTU flow meter for heat exchangers, Elbow taps, Flow switches, Laminar flow meter, Mass flow meter - Coriolis, Miscellaneous, Thermal, Positive displacement gas flow

meter, segmental wedge flow meter, Sight flow indicators, Turbine and other rotary element flow meter, Variable-area, gap and vane flow meter, Venturi tubes, flow tubes and flow nozzles, applications and selections.

**Pressure Measurement:** Bellows type pressure sensor, Bourdon and helical pressure sensor, Diaphragm or capsule type sensor, Differential pressure instruments, electronic pressure sensor, high pressure sensor, pressure repeaters, vacuum sensors, Applications and Selections.

**Unit - IV: Special Purpose Sensors** **(11 Hrs.)**

Baroscopes, Electrical and intrinsic safety, Electrical meters and sensors, Detectors of flame, fire and smoke, Leak detectors, Noise sensor, Speed detectors, Thickness and dimensions detectors, Torque and force transducers, Vibration, shocks and accelerations sensor, weather stations sensor, Weighing-Electronic load cells, Gas sensor-Metal oxide semiconductor type: LPG, CO, Methane, $CO_2$.

**Unit - V:** Presentation, Case studies, Assignments, Tutorials based on Module I to IV **(12 Hrs.)**

**References:**

**Text:**


1. Process Measurement and Analysis- Bela G. Lipta, Instrument Engineers Handbook, Third Edition.
2. Electronics Instrumentation- H. S. Kalsi; Second Edition, 2004, Tata McGraw Hill Publishing Co. Ltd; N. Delhi.
3. Process Control Instrumentation Technology- Curtis D. Johnson, Eastern Economy Edition, PHI Learning Pvt. Ltd. New Delhi.
4. Instrumentation and control- D. Patranabis; publishing PHI Learning Private Limited, New Delhi.
5. Electrical and Electronics Measurement and Instrumentation- A. K. Sawhney; DhanpalRi and Sons.
6. Industrial Instrumentation and Control-S. K. Singh; Second Edition, Tata McGraw Hill Publishing Co. Ltd; N. Delhi.


**Web:**


1. https://nptel.ac.in/courses/108105062/
2. https://nptel.ac.in/courses/103103037/

## ELET - 313: Generic Elective - III (04 credits)

### iii. Smart Fusion Technology based System Design

**Course Objectives:**

1. To introduce the concept of smart fusion technology.
2. To make them understanding of designing of memory components.
3. To introduce the concept of ASIC and How it can be designed.
4. To highlight on study of SoC A2F200M3F.
5. To understand Analog Compute Engine (ACE), Analog Front End (AFE) and features of ADC, DAC, ABPS.

**Course Outcome:**

1. Students can design Different Applications using Smart fusion technology
2. They will develop sophisticated system for dedicated application.
3. Students will use Smart Fusion devices which are ideal for hardware and embedded system designs where there is a need of true system-on-chip (SoC) solution that gives more flexibility than traditional fixed-function microcontrollers.
4. Students will apply Smart Fusion innovative solution for the industrial, medical, energy, communications and military markets in diverse applications, including system management, power management, motor control, industrial networking and display

**Course Contents:**

**Unit –I** **(12 Hrs.)**

Introduction to Fusion Technology Concept of fusion and smart fusion technology, Antifuse, Static RAM, EPROM and EEPROM Technologies Logic modules 1, 2, 3. Shannons Expansion theorem, Multiplexor logic as function generator, ASIC Logic cell, Types of ASIC, ASIC design flow, Combinational, Sequential, Data paths, I/O cells, Cell Compilers

**Unit –II** **(12 Hrs.)**

Architecture of Smart Fusion device Introduction to customizable System-on-Chip (CSoC), Architecture of Smart Fusion Device, Block diagram of Smart Fusion A2F200M3F, Microcontroller Subsystem (MSS), Microcontroller Core, Programmable analog block, Programmable digital block, Programmable communication interfaces, FPGA fabric, : Clocking resources, SRAM , User I/Os, banks and standards . Review of evaluation board of Micro-semi cSoC.

**Unit –III** **(12 Hrs.)**

Programmable Analog: Features of programmable Analog Compute Engine (ACE), Analog Front End (AFE), Features of ADC, DAC, ABPS, Current monitor, Temperature Monitor, High-Speed comparator. Development tools for Microsemi smart fusion device. Re-configurability and

dynamic re-configurability, concept of hardware software co-design, Design tools for smart fusion devices, design flow, Libero SoC, configuration of MSS, Simplify model, sim Softconsole.

**Unit –IV** **(12 Hrs.)**

Programmable SoC design with smart fusion Design of system for
a. Temperature measurement
b. Humidity Measurement
c. Mobile communication
d. Core of 8051 microcontroller

**Unit - V:** Presentation, Case studies, Assignments, Tutorials based on Module I to IV **(12 Hrs.)**

**Text/References Books –**

1. Application Specific Integrated Circuits, Michael Smith, Person Education Asia
2. Datasheet of SmartFusion Customizable System-on-Chip
3. SmartFusion Microcontroller Subsystem Users Guide
4. SmartFusion Programmable Analog Users Guide,

## ELET - 314: Generic Elective - IV (04 Credits)

### i. Characterization Techniques for Electronic Devices

**Course Objectives:**

1. To introduce and make understand the operation of various characterization techniques and associated instrumentation to employ them for entire investigation of the materials

**Course Outcomes:**

After completion of the course students will be able to –

a) Describe the various spectroscopy techniques and their applications.
b) Performed experiments with X-Ray diffraction technique and its applications
c) Perform structural, profile analysis, particle size analysis of samples from data obtained using various spectroscopy techniques.
d) Analyse the graph obtained from XRD technique, perform its interpretation.

**Course Contents:**

**Unit - I: Electrical and Electrochemical Techniques (12 Hrs.)**

**Electrical:** Introduction to ohms law and determination of resistance, resistivity, conductance, conductivity by Voltage-Current (I-V) characteristics, advantages of 4-probe over 2-probe technique, Hall effect, Capacitance-Voltage (CV) Characteristics, Field Effect Transistor output and transfer characteristics.

**Electrochemical Techniques:** Introduction to electrochemistry, oxidation and reduction, balancing redox reactions, electrochemical cells, Nernst equation, Conductance of Electrolytic Solutions, Electrolytic Cells and Electrolysis, reference electrodes (aqueous, non-aqueous and Pseudo reference electrodes), role of counter, working and reference electrodes, Electrochemical Techniques: Potentiostatic, Galvanostatic, Chronopotentiometry, Chronoamperometry, Electrochemical Impedance Spectroscopy (EIS)

**Unit - II: Spectroscopic Techniques (12 Hrs.)**

Basics of Spectroscopy, Interaction of radiation with matter, Theory, working principle and applications of spectroscopic techniques viz. Fourier Transform Infrared spectroscopy, RAMAN Spectroscopy, UV-Visible Spectroscopy, photoluminescence (PL) spectroscopy, ultraviolet photoelectron spectroscopy (UPS), X-Ray Photoelectron Spectroscopy, X-ray absorption spectroscopy, Auger Electron Spectroscopy, Energy dispersive spectroscopy (EDS).

**Unit - III: X-ray Diffraction (12 Hrs.)**

Basics of crystallography, Working principle of X-Ray diffraction, X-Ray Powder diffraction, X-Ray Thin film Diffraction, Grazing Incidence XRD, X-ray powder diffraction –Quantitative

determination of phases; Structure analysis, single crystal diffraction techniques -Determination of accurate lattice parameters -structure analysis-profile analysis -particle size analysis using Scherer formula.

**Unit - IV: Morphological Characterization Techniques** **(12 Hrs.)**

Scanning Tunneling Microscopy (STM), Atomic Force Microcopy (AFM) Scanning Electron Microscopy (SEM), Field Emission - Scanning Electron Microscopy (FE-SEM), Transmission Electron Microscopy (TEM)

**Unit - V:** Presentations, Case studies, Assignments, Tutorials based on Module I to IV **(12 Hrs.)**

**References:**


1. Elements of X-ray Diffraction B. D. Cullity, Addison Wesley, 1977
2. Transmission Electron Microscopy: A Textbook for Materials Science David B Williams, C Barry Carter, (1996) Plenum Press, New York
3. Impedance Spectroscopy: Theory, Experiment, and Applications, E. Barsoukov and J. Ross Macdonald (Editors) (2000) John Wiley & Sons (P) Ltd.
4. Fundamentals of Fourier Transform Infrared Spectroscopy, Brian C Smith, (1995) CRC Press
5. Nanoindentation, By Anthony C Fischercripps, Anthony C., Springer science and Bussiness media publications, 2011
6. Nanomaterials, Nanotechnologies and Design: An Introduction for Engineers, Daniel L. Schodek, Paulo Ferreira, Michael F. Ashby, Elsevier, 2009.

## ELET - 314: Generic Elective - IV (04 Credits)

### ii. Automated Process Control

**Course Objectives:**

To introduce students with operational concepts of automated process control technology

**Course Outcomes:**

1. Discuss basic building box required to design automated process control system.
2. Identify the requirement of distributed control system.
3. Understand the process models & simulation process for industrial automation.
4. Design the different industrial control processes.

**Course Contents:**

**Unit - I: Fundamentals of automatic process control** **(12 Hrs.)**

Process definition, Open loop control & closed loop control, Basic principles of single controller loop, Control system response: Normalized response, Underdamped response, overdamped response. Technology trend: Silicon Transducers & Fiber optic transducers (Displacement Transducers, Temperature transducers, Pressure transducers, Liquid level & liquid flow transducers). MEMS sensors: Introduction, design challenges, Generations, system developments

**Unit - II: Building blocks of Automation system** **(12 Hrs.)**

Processing system, Multi-microprocessor systems & its interconnections, Analog and digital I/O modules, Interrupt control module, Timer/Counter modules, Display control modules, Supervisory control & data acquisition system, Remote terminal unit: I/O modules, communication modules Control elements: MEMS valves introduction, MEMS control valves. Digital controllers: Components & working of DDC, Benefits of DDC, digital controller realization.

**Unit - III: Distributed digital control systems** **(12 Hrs.)**

Introduction, distributed vs. Centralized control, Advantages of distributed control systems, functional requirement of distributed process control system & its evolution, system architecture , distributed control sub - systems, local field station, presentation & monitoring device, communication options. Fieldbus system: its types, foundation, topology, layer, wordfip, profibus, CAN.

**Unit - IV: Industrial Process Automation** **(12 Hrs.)**

Model based automatic control: different process models (Mechanistic models, black box models, qualitative models), definitions, system modeling, uses of system simulation, model evaluation &

improvement, modern tools for modeling & simulation. Industrial control application: Thermal power plant, water treatment plant, irrigation canal automation.

**Unit - V:** Tutorials, assignments and presentation based on Module I to IV **(12 Hrs.)**

**References:**


1. Krishna Kant; 2017; Computer based industrial control (Second edition); PHI Learning PVT LTD; New Delhi (India).
2. N. P. Lieberman, E. P Lieberman; 2014; A Working Guide to Process Equipment (Fourth Edition), Mcgraw - Hill Book CoMyke King; 2010; Process Control: A Practical Approach; Wiley International


**Suggested Reading:**


1. Surekha Bhanot; 2017; Process Control principles & Applications (EIGHTH EDITION); Oxford university press; New Delhi (India).
2. Curtis D. Johnson; 2012; Process Control Instrumentation Technology (EIGHTH EDITION); PHI Learning PVT LTD; New Delhi (India).
3. William Dunn; 2005; Fundamentals of Industrial Instrumentation and Process Control; McGraw Hill; USA


**Web:**

1. https://nptel.ac.in/courses/108105062/2
2. https://nptel.ac.in/courses/108105063/pdf/L01(SM)(IA&C)%20((EE)NPTEL).pdf

## ELET - 314: Generic Elective - IV (04 Credits)

### iii. Biomedical Instrumentation - II

**Course Objectives:**

1. To introduce students to operations of various biomedical transducers
2. To make them understand advanced instrumentation, equipments and systems used in the biomedical field

**Course Outcomes:**

After completion of the course students will be able to –

1. Explain the importance of therapeutic equipments
2. Describe various imaging systems with their relevant aspects.
3. Apply the appropriate biomedical transducer used for specific applications

**Course Contents:**

**Unit - I: Biomedical Transducer (10 Hrs.)**

Classification of transducer, Performance characteristic of transducer, Transducer for body temperature measurement, Displacement, position and motion transducer Pressure transducer, Optical fiber sensors, Bio sensors, Smart sensor

**Unit - II: Opthalmology and Audiology Instrumentation (8 Hrs.)**

Audiometer, Acoustic impedance meter, Evoked response audiometer, Automated perimeter, Funds reflectometer, Tonometer, Eye's movement measurement

**Unit - III: Therapeutic Equipments (12 Hrs.)**

Cardiac pacemaker, Surgical diathermy machine, Ultrasonic therapy unit, Dialyzers Modern lithotriptor systems, Anesthesia machine, Ventilators, mechanics of respiration, Modern ventilators, Radiotherapy instruments

**Unit - IV: Medical Imaging Systems (18 Hrs.)**

Basic of Diagnostic Radiology, X-Rays and Properties of X-ray, X-ray machine, Dental Xray machine, CT scanner, Gamma camera, Nuclear magnetic resonance (NMR) system, Echocardiograph. **Bio-Telemetry:** Introduction, Physiological parameters, Components of bio-telemetry system Implantable units, Applications of telemetry in patient care

**Books Recommended**


1. Handbook of Biomedical instrumentation R.S. Khandpur -Tata Mc Graw Hill (2001)
2. Biomedical instrumentation and measurement (2nd Edition ) Cromwell, wiebell, Pfeiffer. PHI ,Delhi (1996)
3. Medical instrumentation : Application and design (Third Edition) John G.Webster - John Willey & Sons (1998)

**ELEL - 321: Lab Course 5 (Based on ELET-311 and ELET-312) (02 Credits)**

**List of Experiments:**

**I. Section A: based on ELET - 311: Programmable Logic Controller**

1. Develop ladder programming to implement (i) basic logic gates and (ii) sequencing operations employing timers (lamp output)
2. Develop ladder programming to implement counter operation (proximity sensor to be used as event indicator) for triggering an enunciator after a certain batch of count is over
3. Develop ladder programming to operate a conveyor based liquid vending station
4. To study operation of
5. Develop ladder programming to operate a density based traffic light arrangement
6. Develop ladder programming to operate an X-Y plotter
7. Develop ladder programming to address different sequence of operation in a real time batch process unit (should contain at least two liquid tanks as main storage, one mixing tank, stirrer, heater, liquid dispenser, conveyor based handling, liquid level indicators etc.).
8. Develop program for at least two real time industrial processes with ITS – PLC virtual platform

**II. Section B: based on ELET - 312: Internet of Things**

1. Study of physical and soft component in a IoT System
2. Shell scripting programming for IoT
3. Study of Arduino/Python programming
4. Study of hardware (Sensors and Actuators) interfacing protocol for IoT
5. Controlling an LED using ESP8266 module
6. Reading data from GPIO pin of ESP8266 module
7. Study of Communication protocols (at least 2)
8. System development for agriculture/ ambient atmospheric condition

**(Students are expected to complete at least 04 experiments from each section)**

**ELEL - 322: Lab Course 6 (Based on ELET - 313 (i) and ELET - 314 (i))** **(02 credits)**

**List of Experiments:**

**I. Section A: based on ELET-313: i) Fabrication Techniques for Electronic Devices**

1. Study of Coating of Chromium on glass substrate using electron beam evaporator
2. Coating of Aluminium on glass substrate using Thermal coating technique
3. Coating of Chromium (20nm) and aluminium (180nm) on glass substrate using electron beam evaporator and thermal coating techniques
4. Wet chemical etching of Indium Tin Oxide (ITO) coated glass
5. Photo-resist coating and pattern transfer by photolithography technique
6. $SiO_2$ coated Silicon thin film characterization using Grazing Incidence X-ray diffraction (GIXRD)
7. X-ray Micro diffraction study of materials coated between microelectrodes

**II. Section B: based on ELET-314: i) Characterization Techniques for Electronic Devices**

1. Characterization and analysis of ethanol using Fourier Transform Infrared Spectroscopy (FTIR)
2. Characterization and analysis of ethanol using Uv-Visible spectroscopy
3. Characterization and finding lattice parameters (hkl) parameters of NaCl crystal using powder X ray diffraction (PXRD) method
4. Characterization and finding lattice parameters (hkl) parameters of given thin film using Grazing Incidence X ray diffraction (GIXRD) method
5. I-V and FET measurement of two terminal and three terminal devices
6. Measurement and analysis of thin film using Electrochemical Impedance Spectroscopy (EIS)
7. Probing Raman active nodes using Raman Spectroscopy
8. Surface topography using AFM

**(Students are expected to complete at least 04 experiments from each section)**

**ELEL-322: Lab Course 6 (Based on ELET-313 (ii) and ELET-314 (ii))** **(02 credits)**

**List of Experiments:**

**I. Section A: based on ELET-313: ii) Instrumentation in Process control**

1. Study of Displacement sensor
2. Study of Potentiometric sensor
3. Study of LVDT as displacement Sensor
4. Study of digital encoder
5. Study of characteristics of IC temperature sensor (LM 35)
6. Study of ultrasonic sensor for level/distance measurement
7. Study of pressure sensor
8. Study of Gas sensor based on metal oxide semiconductor
9. Study of proximity sensor

**II. Section B: based on ELET-314: ii) Automated process Control**

1. Study of optical fiber pressure sensor
2. Study of optical fiber chemical sensor
3. Study of optical fiber displacement sensor
4. Study of optical fiber liquid level/liquid flow sensor
5. Study of network topologies
6. Study of fieldbus system
7. Study of Bluetooth network
8. Study of Profibus

**(Students are expected to complete at least 04 experiments from each section)**

**ELEL - 322: Lab course 6 (based on ELET-313 (iii) and ELET-314 (iii))** **(2 Credits)**

**List of Experiments:**

**Section A: based on ELET 313: iii) Smart Fusion Technology based System Design**

**Lab experiments using Verilog/ Keil**

1. Design Logical Gates Using FPGA.
2. Design of Flip Flops Using FPGA.
3. Design of 4:1/ 8:1 Multiplexer Using FPGA.
4. Design of RAM (Memory Devices)
5. Design System for Temperature measurement.
6. Design System for Humidity measurement.
7. Design System for mobile communication.

**Section B: based on ELET 314: iii) Biomedical Instrumentation - II**

1. Analysis of bio signals using spectrum analyzer.
2. Study of characteristics of optical Isolation amplifiers.
3. Study of Heart rate counter
4. Study of Electronic stethoscope.
5. Study of Bed - side patient monitoring system
6. Study of Pace maker

**(Students are expected to complete at least 04 experiments from each section)**

**ELER - 331: Research Project - Part III** **(02 Credits)**

(Experimental Work along with Analysis and Interpretation Results)

Students are expected to do the followings;

a) Continue the experimental work which was initiated in 2nd semester
b) Complete analysis and interpretation of results

# Semester - IV

## Semester IV (Foundation and Generic Elective Courses)

### ELET - 411: Advance Communication Systems (04 Credits)

**Course Objectives:**

1. To introduce the students to advanced topics in digital communications.
2. To recognize different communication systems
3. To provide the students with understanding of the fundamental concepts and techniques, used in the performance analysis, and implementation of current communication systems in the development of the communication systems of the future.

**Course Outcomes:**

On completion of the course, students should be able to-

1. understand the basics and technology of advanced communication system
2. understand concept of mobile communication system and satellite communication system
3. understand concept of telecommunication switching and networks
4. understand the difference between analog and digital communication systems
5. understand the construction, principle of operation and applications of advanced optical components
6. know the different types of optical sensors

**Course Contents:**

**Unit - I: Mobile Communication** **(12 Hrs.)**

**Cellular concept:** Introduction to basic cellular system, Cellular coverage planning, Mobile radio propagation, frequency reuse, Co-channel interference, Diversity, fading channels, spreading codes, power control, handoff, types of handoff, Multiple access. **Wireless networking:** Wireless systems and standards, WAP and other protocols for internet access. Blue-tooth and other wireless networks, system comparison. Spread spectrum concept. Basics of CDMA. Applications of CDMA to cellular communication systems. Second and third generation CDMA systems/ standards. Multicarrier CDMA. Synchronization and demodulation. Diversity techniques and rake receiver. **Mobile Unit** : Block diagram and operation of mobile unit, block diagram of cellular network, GSM architecture, making a call, receiving a call, GSM and CDMA technology and their applications.

**Unit - II: Telecommunication Switching and Networks** **(12 Hrs.)**

Principles of circuit switching and signaling schemes, space time and space time division switching, single stage and multistage switching network. Traffic engineering and tele-traffic theory, Markov processes representing traffic, calculation of blocking probability.

**Unit - III: Advanced Optical communication** **(12 Hrs.)**

Analog and Digital communication link design, WDM, DWDM, optical couplers, Mach-Zehnder interferometer multiplexer, optical add/drop multiplexers, isolators, circulators, optical filters, tunable sources and tunable filters, arrayed waveguide grating, diffraction grating, optical amplifiers, optical integrated circuits, OTDR, SONET: frame format, overhead channels, payload pointer, multiplexing hierarchy. SDH: Standards, frame structure and features. Optical switching, WDM networks, Classification of optical sensors, Intensity modulated, phase modulated and spectrally modulated sensors

**Unit - IV: Satellite communication** **(12 Hrs.)**

Introduction to satellite communication system, Importance of satellite communication system, concept of orbit and its types, Kepler's law, orbit tracking, satellite launching, attitude control, main and auxiliary propulsion subsystem, earth station and satellite sub systems, satellite link: uplink and downlink frequency, satellite link design and analysis, multiplexing techniques, multiple accesses for satellite links: FDMA, TDMA CDMA and DAMA, propagation effects, DBS-TV, GPS. VSAT: Network architecture, access control protocol and link analysis.

**Unit - V:** Tutorials, assignments and presentation based on Module I to IV **(12 Hrs.)**

**Text/Reference Books:**


1. An introduction to fiber optic systems (IInd edition) By John Powers, Irwin Publications, Chicago (1993 & 1997)
2. Understanding fiber optics (IInd edition) By Jeff Hecht (BPB publications) 1997
3. Principles and Applications of Optical Communications, By Max Ming-Kang Liu, Irwin Publications, Chicago
4. Mobile cellular Telecommunications: Analog and Digital Systems (IInd edition) By William C.Y. Lee, McGraw-Hill, Inc. New York, 1995
2. Optical Communication System, John Gower, Prentice Hall, India

## ELET - 412: General Elective - V (04 Credits)

### i) Electrochemical Energy Storage System

**Course Objectives:**

1. To introduce students to basic concepts of Battery
2. To make them understand crucial performance parameters as well as manufacturing of batteries
3. To facilitate students to understand super capacitors and fuel cells

**Course Outcomes:**

On completion of the course, students should be able to-

a) understand the basics concept of batteries
b) understand the performance criteria of batteries
c) understand various manufacturing aspect of batteries
d) develop super-capacitors and fuel cells

**Course Contents:**

**Unit - I: Basic concepts and Batteries** **(12 Hrs)**

Reversible cells and irreversible cell reactions, Parameters for characterizing batteries, Primary and Secondary cells, Chemistry and materials used for various components (electrodes, electrolytes, separator and binders) of different types of batteries: Leclanche/Dry/Alkaline cell, Silver cell, Mercury cell, Lead-acid battery: safety and design; Edison Cell, Ni-Cd battery, Ni Metal Hydride (Ni-MH) battery, Ni-Hydrogen battery, Sodium-Sulfur battery, Lithium-ion/Lithium-polymer/ Li-S battery, Metal-air batteries and its applications

**Unit - II: Performance and Manufacturing of Batteries** **(12 Hrs)**

Charge-Discharge characteristics, Energy/power density, overcharging, Mechanics of battery cells and materials, Manufacturing of batteries, Battery safety and Abuse tolerance, Coupling with other energy storage devices

**Unit - III: Super/ultra-capacitors** **(12 Hrs)**

Fundamentals of Electrochemical Supercapacitors, Electrode and electrolyte interfaces and their capacitances, Charge-Discharge characteristics, Energy/power density, Design, Fabrication, operation and evaluation, Thermal management; Supercapacitor stack manufacturing and construction, Coupling with batteries and fuel cells; Applications

**Unit - IV: Fuel cells** **(12 Hrs)**

Overview of key fuel cell technologies- various types of fuel cells, materials for electrodes, electrolytes and other components, working mechanisms, hydrogen generation and storage; limitations, recent progress in fuel cells.

**Unit - V:** Tutorials, assignments and presentation based on Module I to IV **(12 hrs)**

**References:**


1. A. J. Bard, L.R. Faulkner, Electrochemical Methods, Fundamentals and Application. Wiley, 2001.
2. C. Daniel and Jurgen O. Besenhard, Handbook of Battery Materials, Wiley-VCH Verlag, 2011
3. K. E. Aifantis, S. A. Hackney, and R. V. Kumar (Ed.) High Energy Density Lithium Batteries Materials, Engineering,
4. Applications, WILEY-VCH Verlag GmbH & Co. KGaA, 2010.
5. A. Yu, V. Chabot, and J. Zhang, Electrochemical Supercapacitors for Energy Storage and
6. Delivery Fundamentals And Applications, Taylor & Francis Group, 2013.
7. F. Beguin and E. Frackowiak, Supercapacitors- Materials, Systems, and Applications. Wiley- VCH Verlag GmbH & Co. 2013.
8. V. Hacker, S. Mitsushima(Eds.), Fuel Cells and Hydrogen: From Fundamentals to Applied Research, **Elsevier**

**ELET - 412: General Elective - V** **(04 Credits)**

### ii. Micro-electromechanical System and Applications

**Course Objectives:**
To introduce students to-

a) Various MEMS fabrication technologies
b) MEMS-specific design issues and constraints
c) Dynamics and modeling of microsystems
d) Applications of microsensors and microactuators
e) Getting access to fabrication and testing in academia and industry

**Course Outcomes:**
On completion of this course, the student will be able to-

a) Explain the operation of microdevices, microsystems and their applications
b) Design the microdevices, microsystems using the MEMS fabrication process.
c) Establish the basic approaches for various sensor and actuator design
d) Develop experience in micro/nanosystems for photonics.

**Course Contents:**

**Unit - I: Introduction to Micro-electromechanical systems and MEMS design** **(08 Hrs)**

What is MEMS? MEMS technology, a brief history of MEMS, MEMS design tools, bulk-micromachining based MEMS design, surface-micromachining based MEMS design.

**Unit - II: Material issues for microsystems** **(08 hrs)**

Failure mechanisms of materials used in Microsystems, methods for measuring mechanical properties of materials used in Microsystems structure materials for Microsystems, materials for the micro-tribological application.

**Unit - III: MEMS processing and fabrication techniques and technology** **(10 Hrs)**

Silicon-based micromachining, surface micromachining technology: standard surface micromachining technology and multilayer polysilicon, metallization, isolation, monolithic integrated surface micromachining technology, 3D surface machining, other materials, bulk micromachining.

**Unit - IV: Micro-electromechanical sensors and MEMS Packaging** **(22 Hrs)**

Physical sensors, chemical sensors, biological sensors, resonant pressure sensors, resonant accelerometers, resonant gas flow sensors, silicon-based electrostatic field sensors, MEMS-based micro gas sensors, micro-hotplate Gas sensor, micro-gas sensor array, nanofiber-based gas sensing materials.

**MEMS Packaging**: MEMS packaging fundamentals, contemporary MEMS packaging approaches, bonding processes for MEMS packaging: fusion bonding, anodic bonding, epoxy bonding, eutectic bonding, solder bonding, localized heating and bonding, Vacuum packaging: integrated micromachining, post packaging, hybrid approach.

**Unit - V:** Tutorials, assignments and presentation based on Module I to IV **(12 Hrs)**

**References:**


1. Microsystems and nanotechnology, Zhaoying Zhou, Zhonglin Wang, Liwei Lin, Springer.
2. MEMS AND Microsystems: Design And Manufacture 1st Edition, Tai-Ran Hsu, Mcgraw Hill Education.
3. Mems and Nems, Lyshevski, CRC press.
4. Advanced Mechatronics and MEMS Devices 1st Edition, Dan Zhang, Springer New York.
5. MEMS, MAHALIK N P, Mcgraw Hill Education.

## ELET - 412: General Elective - V (04 Credits)

### iii. Solar Photovoltaic Systems

**Course Objectives:**

1. To introduce students to photo thermal systems and estimation of solar power energy
2. To make them understand various photovoltaic basics to solar cell
3. To enable students to understand grid connected systems, implementation and some case studies

**Course Outcomes:**

On completion of the course, students should be able to-

a) understand the basics concept of Photo thermal systems
b) understand the basics of Photovoltaic devices
c) design Photovoltaic systems
d) install Photovoltaic systems

**Course Contents:**

**Unit - I: Photo thermal systems** **(12 Hrs.)**

Flat Plate Collector, Hot Air Collector, Evacuated Tube Collector, Parabolic, Compound Parabolic and Fresnel Solar Concentrators, Central Receiver System, Thermal Analysis of Solar Collectors Performance of Solar Collectors, estimations of power obtained from solar energy.

**Unit - II: Photovoltaic Basics** **(12 Hrs.)**

Structure and working of solar cells and panels, types of solar cells, electrical properties and performance of solar cell
Stand-alone PV systems: Schematics, components, inverters, batteries, charge conditioners, balance of system components for DC and/or AC applications, typical applications for lighting, water pumping etc.

**Unit - III: Grid-connected systems** **(12 Hrs.)**

Schematics, components, charge conditioners, interface components, balance of system, components, PV System in Buildings.
Design and analysis of PV systems, F Chart Method, φ-F Chart method, Utilizability, Modelling and Simulation of Solar Energy Systems, radiation and its load analysis, sizing and reliability testing.

**Unit - IV: Techniques and Case Studies** **(12 Hrs.)**

Installation techniques, Commissioning and Engineering Practices, MPPT charge controllers, Solar power tracking and monitoring using PLC and SCADA systems,. Energy yield and economics of a PV systems, Case studies: 600W / 12 kW PV system

**Unit - V:** Tutorials, Assignments and Presentation based on Module I to IV **(12 Hrs.)**

**Recommended Books**


1. CS Solanki: Solar Photovoltaics – Fundamentals, Technologies and Applications, PHI Learning Pvt. Ltd., 2011.
2. Martin A. Green, Solar Cells Operating Principles, Technology, and System Applications Prentice- Hall, 2008

**ELET - 412: General Elective - V** **(04 Credits)**

### iv. PC Based Instrumentation

**Course Objectives:**

To introduce students about

a) introduction of personal computer and peripherals
b) learning of programming techniques
c) understanding of data Acquisition in Virtual Instruments
d) understanding of PC for Measurement and Control

**Course Outcomes:**

After completion of the course students will be able to –

a) Describe the various components of personal computers, working principle of serial, parallel communication used in computers
b) Analyze with data acquisition techniques in virtual instrumentation.
c) Control and monitor temperature, pressure, torque and load using personal computer.
d) Design and develop a simple application using PID controller.

**Course Contents:**

**Unit - I: Introduction to Personal Computer (PC) and Peripherals** **(12 Hrs.)**

Computer organization and architecture – Computer components and interconnections – Memory management – I/O devices - PC extension slots (ISA, EISA & PCI). Serial, parallel and USB ports and their applications. IEEE 488 and GPIB bus standard.

**Unit - II: Programming Techniques** **(12 Hrs.)**

Virtual Instrumentation- Definition, flexibility- Block diagram and Architecture of Virtual Instruments- Data flow techniques- graphical programming in dataflow. Loops and charts, arrays, clusters and graphs, case and sequence structures, forma nodes, local and global variables, string and file Input/output, Instrument drivers.

**Unit - III: Data Acquisition in Virtual Instruments** **(12 Hrs.)**

Introduction to data Acquisition-signal conditioning –classes of signal conditioning-field wiring and signal measurement-ground loops-A/D, D/A converters, Design and interface of digital input/output and timer (DIOT) cards, Plug-in DAQ boards- Data acquisition modules with parallel and serial communication

**Unit - IV: PC for Measurement and Control** **(12 Hrs.)**

Role of PC in instrumentation, Application of PC for measurement of Temperature, Pressure, Torque, Load, Displacement and $P^H$. Waveform generation- data visualization at multiple

locations. Real time control and applications: design of ON/OFF controller, PID controller, PC based digital storage oscilloscope. PC based UV - Visible spectrophotometers.

**Unit - V:** Tutorials, assignments and presentation based on Unit I to IV **(12 Hrs.)**

**References:**


1. Microprocessor and Interfacing: Programming and Hardware – Douglas V. Hall
2. S.Gupta and J. P. Gupta, " PC interfacing for data acquisition and process control", Second Edition, Instrument Society of America, 1994.
3. Lab VIEW based Advanced Instrumentation Systems - S. Sumathi and P. Surekha ISBN-10 3-540-48500-7 Springer Berlin Heidelberg New York.
4. John Park and Steve Mackay, Practical Data Acquisition for Instrumentation and control Systems, Elsevier Publications.

## ELET - 413: General Elective - VI (04 Credits)

### i) Optoelectronics and Optical Fiber Communication

**Course Objectives:**

1. A introduce students to various optoelectronic sources and detectors
2. To introduce students to basics of fiber optics communication
3. To make them understand the modal analysis of fiber optics

**Course Outcomes:**

On completion of the course, students should be able to-

1. understand various optoelectronic systems
2. understand various concepts of Optical fibres
3. develop optical fiber communication systems

**Course Contents:**

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

Lamps and illumination systems, LEDs – working principle and applications, LED lighting, Display devices, indicators, numeric, alphanumeric and special function displays, Liquid Crystal Display elements, Plasma Displays, Multimedia projectors, Semiconductor lasers, Fabry-Perot lasers, Distributed Feedback, (DFB) lasers, Distributed Bragg Reflection (DBR) lasers

**Unit - II:** **(12 Hrs.)**

Photo-detectors types and applications, PN and PIN Photodiodes, Avalanche Photodiodes (APD) Opto-couplers, Opto-interrupters, LASCR, used in safety interlocks, power isolators, rotary and linear encoders and remote control, Intrinsic and Extrinsic Fiber optic sensors.

**Unit - III:** **(12 Hrs.)**

Optical Fiber Theory, Parameters of Optical Fibers, Types of Optical Fibers-Single Mode and Multi Mode Fibers, Step Index & Graded Index Fibers. Modal Properties-Waveguide Parameter (V Number), Cut-off wavelength, Dispersion-Intermodal and Intramodal dispersion Loss, Mechanism in Optical Fibers-Adsorption and Scattering, Fresnel Reflection, Micro bending & Macro bending, Connector types and Splices, Misalignment and Mismatch losses

**Unit - IV:** **(12 Hrs.)**

Fiber-Optic transmitters and receivers, Direct Modulators, External Modulators-Electro-Optic Modulators, Electro-Absorption Modulators, Noise in detection process, Noise Equivalent Power (NEP). Single Channel System Design, Power budgeting, Transmission Capacity Budgeting, Dispersion Compensation, Nonlinear effects in optical fibers-Stimulated Brillouin Scattering

(SBS), Self-Phase Modulation (SPM), Cross-Phase Modulation (XPM), Four-Wave Mixing (FWM).

**Unit - V:** Tutorials, assignments and presentation based on Module I to IV **(12 Hrs.)**

**Text / Reference Books:**


1. Optical Engineering Fundamentals B.H. Walker, PHI
2. Electro-Optical Instrumentation Sensing and Measuring with Lasers: SilvanoDonati, Pearson
3. Fiber optics and Optoelectronics: R.P. Khare, Oxford Press.
4. Optical Fiber Communication Principles and Systems A. Selvarajan, S.Kar and Srinivas, TMH
5. Optical Fiber Communications G. Keiser, TMH

## ELET - 413: General Elective - VI (04 Credits)

### ii) HMI, SCADA basics and Databases

**Course Objectives:**

1. To introduce students to concept of SCADA
2. To make them understand various protocols in regard of SCADA
3. TO make them enable to employ SCADA systems in appropriate applications

**Course Outcomes:**

On completion of the course, students should be able to –

a. State the basic features of SCADA, HMI
b. Develop architecture of SCADA and explain the importance of SCADA in critical infrastructure.
c. Analyze the theory and applications of SCADA
d. Develop projects with SCADA and HMI
e. Implementation of SCADA application.

**Course Contents:** **(12 Hrs.)**

**Unit - I: Project Development and HMI**

Project Development: Creating Project, Screens project Configuration, Device Settings, Communication Configuration and Defining Tags, Graphic Control: Planning Graphic Design, Screen Preparation and Navigation Control, Graphic Elements and Libraries and Linking Objects with Tags, Other HMI Features: Tag Logging, On Line and Historical Trending, Alarm System – Designing and Handling and Recipes- Designing and Handling, User Administration and Transferring Project to HMI **(12 Hrs.)**

**Unit - II: SCADA System**

Introduction, definitions and history of Supervisory Control and Data Acquisition, typical SCADA system Architecture, Communication requirements, Desirable Properties of SCADA system, features, advantages, disadvantages and applications of SCADA. SCADA Architectures (First generation - Monolithic, Second generation - Distributed, Third generation – Networked Architecture), SCADA systems in operation and control of interconnected power system, Power System Automation (Automatic substation control and power distribution ), Petroleum Refining Process, Water Purification System, Chemical Plant **(12Hrs.)**

**Unit - III: SCADA Protocols**

Open systems interconnection (OSI) Model, TCP/IP protocol, DNP3 protocol, IEC61850 layered architecture, Control and Information Protocol (CIP), Device Net, Control Net, Ether Net/IP, Flexible Function Block process (FFB), Process Field bus (Profibus). Interfacing of SCADA with PLC

**Unit - IV: Various Case Studies on SCADA Applications** **(12 Hrs.)**

**Case** Study on Controlling Electrical Power System Network, Manufacturing Industries and Waste Water Treatment and Distribution Plants

**Unit - V:** Tutorials, Assignments and Presentation based on Module I to IV **(12 Hrs.)**

**References:**


1. Ronald L. Krutz, "Securing SCADA System", Wiley Publications.
2. Stuart A Boyer, "SCADA supervisory control and data acquisition", ISA, 4th Revised edition 4. Gordan Clark, Deem Reynders, "Practical Modern SCADA Protocols", ELSEVIER
3. Scada: Supervisory Control And Data Acquisition 4th Edition by Author Stuart A. Boyer ISBN-13: 978-1936007097 ISBN-10: 1936007096
4. A Guide to Utility Automation: Amr, Scada, and: it Systems for Electric PowerPaperback – Import, 15 Jan 1999 by Author Michael Wiebe
5. Power System SCADA and Smart Grids 1st Edition by Mini S. Thomas (Author), John Douglas McDonald (Author) ISBN-13: 978-1482226744 ISBN-10: 148222674X
6. Behrouz A. Forouzan 2005, Data Communications Networking, McGraw-Hill Education [ISBN: 9780071254427]
7. David Bailey 2003, PRACTICAL SCADA FOR INDUSTRY, NEWNES [ISBN: 13: 978-0-7506-5805-8]

## ELET - 413: Generic Elective - VI (04 Credits)

### iii. Electronics and Automation in Agriculture

**Course Objectives:**

1. To introduce students to basic concepts of agriculture in the perspectives of automation
2. To facilitate students to explore the equipments, use of computers and information technology in agriculture
3. To introduce students to greenhouse instrumentation

**Course Outcomes:**

**Course Outcomes:**

On completion of the course, students should be able to –

a. Understand basic concepts of soil science and crop science
b. Develop agriculture equipments and automation
c. Analyze the requirements computer technology in agriculture
d. Develop projects based on agriculture automation

**Course Contents:**

**Unit - I: Basics of Agriculture (12 Hrs.)**

Introduction to Soil Science- Soil structure, Soil properties, Soil processes Formation of Soil, types of soils, Organisms and soil processes, Soil as a medium for plant growth, Soil moisture & efficiency, soil pH values and crop production, Chemical analysis of soil, water bearing capacity, Soil erosion and conservation, measurement of soil parameters.
Introduction to Crop Science - Elementary crop science, Basic principles and advances in photosynthesis, Paste and disease management, Post harvesting, Role of fertilizers, Different types of crops. (Floriculture, Horticulture, Mushroom culture, etc.)

**Unit - II: Agriculture equipments and Automation (16 Hrs.)**

Introduction to agriculture measurement techniques: Agricultural parameters (Temperature, pH, Conductivity, Salinity, Soil Moisture,) operating principles of sensors and actuators for Agriculture, Measurement of temperature, Measurement of pH and conductivity, Soil analysis and soil testing, soil moisture measurement, Introduction to Agro meteorology: RH, Wind speed and direction, Radiation, rain Agro meteorological instruments: Anemometer, Use of PLDs, Microprocessors and Microcontroller, Data converters, Display devices, in agricultural automation. Use of opto-electronic devices for measurement and control of physical parameters in agri-electronics, Salinity tester, specific ion analyzer, field usable, pH meter, Agricultural equipment and automation, Automatic drip irrigation.

**Unit - III: Computers and Special Information technology in Agriculture** **(12 Hrs.)**

SIT, GIS/ GPS software's Applications for Ground water modeling, crop forecasting & estimate, soil erosion etc, Use of Digital Image processing, Satellite missions, Hyper spectral remote sensing, physics of optical & microwave remote sensing, thermal mapping. Simulators used for study of crop growth. Data logger, features of data loggers, data loggers for dedicated use in agriculture, Computer based automatic weather station.

**Unit - IV: Green House Instrumentation** **(12 Hrs.)**

Green House Instrumentation: Green House Technology introduction, instrumentation required for tissue culture techniques, Use of simple electronic circuits for control for physical parameters like temperature, humidity and irrigation, and indication of physical parameters.

**Unit - V:** Tutorials, assignments and presentation based on Module I to IV **(12 Hrs.)**

**References:**


1. Treaties on Agro-Physics & Agri electronics: Dr. G. N. Acharya & Dr. D. G. Hapse
2. Fundamentals of remote sensing: George Joseph
3. Fundamentals of Soil: V. N. Sahi- Kalyani Publication
4. Principles of Agricultural Engineering – A. M. Michale
5. Spatial information technology- I. V. Muralikrishna Vol I & II BS Pub.

**ELET - 414: Open Elective (Service Course from Other Department) (04 Credits)**

Students are expected to choose any one course of 04 credit from any one of the University Department during this semester.

**ELEL - 421: Lab course 7 (Based on ELET - 411 and ELET- 412 (i))** **(02 Credits)**

**List of Experiments:**

**I. Section A: based on ELET - 411: Advance Communication System**

1. Study of intensity modulation and demodulation using fiber optic kit.
2. Study of free space communication using fiber optic kit.
3. Study of TDM and de-multiplexing using fiber optic kit.
4. PC to PC data communication using WDM.
5. Setting of fiber optic analog and digital link.
6. Study of mobile communication.

**II. Section B: based on ELET - 412: i) Electrochemical Energy Storage Systems**

1. Study of CV of supercapacitor electrodes
2. Calculate the Charge/ discharge capacitance of half cell supercapacitor
3. Study of CV of full cell supercapacitor
4. Calculate specific capacitance of the fabricated supercapacitor
5. Study of Charge-Discharge characteristics of given battery
6. Study of Charge-Discharge characteristics of given super/ultracapacitor.
7. Study of Electrode and electrolyte interfaces and their capacitances
8. Study of Energy/power density characteristics of given super/ultra capacitor
9. Study of Energy/power density characteristics of given battery

OR

**II. Section B: based on ELET- 412: ii) Micro-electromechanical System and Applications**

1. Fabrication of carbon nanotubes based field effect transistor
2. Fabrication of graphene based field effect transistor
3. Fabrication of conducting polymer based field effect transistor
4. Fabrication of MEMS-based micro gas sensor
5. Fabrication of MEMS-based micro chemical sensor
6. Fabrication of MEMS-based micro bio-sensor
7. Bonding of MEMS micro-device using Probe station

**OR**

**II. Section B: based on ELET - 412: iii) Solar Photovoltaic System**

1. Current-voltage characteristics of Solar cell
2. Study and measurement of Solar Radiation
3. Measurement of PV module parameters
4. Study of Charge Controller and Inverter parameters
5. Study of Testing of Standalone PV system
6. Study of Inverter, Rectifier and Transformer

**OR**

**Section B: based on ELET – 412 iv) PC Based Instrumentation**

1. Study of Serial and Parallel port communication
2. Study of GPIB Bus Standard.
3. Study of IEEE 488 protocol
4. Study of loop, chart, arrays cluster and graphs
5. Design of interface of digital input and output and timers
6. Study of PC based UV Spectrophotometer.

**(Students are expected to complete at least 04 experiments from each section)**

**ELEL - 422: Lab course 8 (Based on ELET - 413)** **(02 Credits)**

**List of Experiments:**

**Experiments based on ELET - 413: i) Optoelectronics and Optical Fiber Communication**

1. Study of characteristics of photoconductive cell.
2. Study of characteristics of photovoltaic cell.
3. Study of characteristics of phototransistor
4. Study of characteristics of photodiode.
5. Study of hetero-junction diode.
6. Study of Opto-coupler.

OR

**Experiments based on ELET - 413: ii) HMI, SCADA basics and Databases**

1. PLC interfaced with SCADA and status read/command transfer operation.
2. Parameter reading of PLC in SCADA
3. Alarm annunciation using SCADA
4. Reporting and trending in SCADA System
5. Tank Level control using SCADA System
6. Temperature monitoring using SCADA System
7. Speed control of machine by SCADA System

OR

**Experiments based on ELET - 413: iii) Electronics and Automation in Agriculture**

1. Measurement of soil parameters (pH, conductivity, moisture)
2. Measurement of meteorological parameters (wind speed, wind direction, temp.)
3. Use of GPS software to gather data related agriculture
4. Development of automation for green house parameters using microcontroller / PLC.
5. Development of automated drip irrigation system using microcontroller / PLC.
6. To design, built and test temperature controller for green house applications.

**(Students are expected to complete at least 05 experiments from each section)**

**ELER - 431: Research Project Part - IV** **(02 Credits)**

(Experimental Work along with Analysis, Interpretation Results, Drafting of Manuscript for Publication and Dissertation)

Students are expected to continue their experimental work of the research project

Students are expected to do the followings;

a) Complete remaining experimental work which was initiated in 2nd semester
b) Complete analysis and interpretation of results
c) Drafting of research manuscript for publications
d) Draft the dissertation of the research project
e) Make presentation of complete project ( based on the work carried out from 1st to 4th semester )

## Bridge Course ( 30 Contact Hours)

1) Students are expected to choose any one of the following courses
2) Respective teachers of University Department OR Affiliated College will be teaching one the following courses before commencement of regular classes of the first semester only.
3) This would be considered as non credit course
4) Examination will be conducted by the respective teachers at Department / College level and marks will not be reflected on Mark sheet
5) It would not be counted in the regular workload

**Course I : Digital Electronics ( 30 Contact Hours)**

**Course Objectives:**

- To enhance subject skills in the area of digital electronics
- To bridge the gap between the student knowledge in the area of digital electronics and advice course based on concept of digital electronics to be taught during M. Sc Electronics

**Course Content:**

**Number System, Logic Gates and Flip Flops**

Number System: Decimal, Binary, Hexadecimal Number Systems and their inter conversions , Binary arithmetic (addition, subtraction, multiplication and division), 1's and 2's compliment method for binary subtraction, Hexadecimal addition and subtraction, 8421 (BCD) code, Gray code, Excess-3 code, BCD addition and subtraction, **Logic gates:** NOT gate, AND gate, OR gate, NAND gate, NOR gate using diodes & transistors, **Flip Flops** : S-R Flip Flop, J-K Flip Flop, Masters Slave J-K Flip Flop.

**Combinational logic circuits**:

AND-OR logic, AND-OR-NOT logic, Ex-OR gate, Ex-NOR gate, NAND and NOR gate as universal building blocks, Half adder, Full adder, Half subtractor, full subtractor,

**Course II : Soft Skills and Entrepreneurship ( 30 Contact Hours)**

**Course Objectives:**

- To enhance linguistic skills necessary for overall development and effective communications
- To get preliminary knowledge about technical documentation, project proposals
- To get introduced to the concepts of entrepreneurship development, management techniques
- To learn interview techniques

1. **Development of Scientific Writing Skills**

2. **Entrepreneurship Development**

- Identification of opportunities of self-employment in the field of electronics
- To visit a Government financial institute which provides financial support for Small Scale Industry (SSI)
- Interview of successful entrepreneur
- Arranging a lecture/ workshop of successful entrepreneur/s

3. **Language skill Development**

- To read at least three books (novels, stories, scientific fictions etc.) and submit summary (worth 5 pages) of each book. Summary should include the individual remarks about the book in general.
- To prepare the collection of articles about a particular topic (say a theme). These articles may from newspapers, magazines, special issues, journals etc. They should be of general knowledge type without going into the complexities or mathematics of the topic. The collection should be arranged in a sequence to give completeness. It should have the comments of the students.

4. **Personality Development**

1. Introducing One self
2. Writing Bio data
3. Facing interviews
4. Participating in Group Discussion
5. Methods to improve confidence and communication skills
6. Preparing for open defenses or oral examination or participating in seminar
7. Collecting information about Address, reference, personalities, institutions
8. Planning a small study tour/arranging Welcome and sendoff functions
9. Introduction to a Function/ to a Chief Guest/ Vote of Thanks
10. Listening, speaking, reading, writing skills
11. Library and reference skills
12. Dramatization of a particular theme
13. Interpreting technical, advertisement/document
14. Hobbies
15. Social awareness