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 June 2017 and onwards)

Department of Electronics

Dr. Babasaheb Ambedkar Marathwada University

Aurangabad – 431004

Maharashtra, INDIA

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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 department. 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 department.

Head of Department

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 106 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	09	36	Sem I - 12 Sem II - 08 Sem III - 08 Sem IV- 08
3	Generic Elective	Theory	06	24	Sem I - 04 Sem II - 08 Sem III - 08 Sem IV- 04
7	Open Elective[#]	Theory	01	04	Sem IV - 04
8	Laboratory courses (Core, Foundation and Generic Elective)	Practical	05	15	Sem I - 06 Sem II - 03 Sem III - 03 Sem IV- 03
11	Research Component	Research/Industrial Project/ Product Development	05	25	Sem I - 04 Sem II - 06 Sem III - 09 Sem IV- 06
			Total	**106 Credits**	

The above structure exercised component wise distribution as per following –

Constitution of India = 02 Credits
Core and Foundation Component = 34 %
Elective Component = 26 %
Research component = 23.5 %
Laboratory Courses = 38 %

[#]Students can opt for open electives from courses offered by other departments in University campus

Course Structure of M. Sc. (Electronics)

Semester I (Core and Foundation and Generic Elective Courses)				
Course	**Course Title**	**Teaching time/week**	**Marks**	Credits
ELET-111	Electronics System	4 hours	100	4
ELET-112	Industrial Power Electronics	4 hours	100	4
ELET-113	Embedded Systems - I	4 hours	100	4
ELET-114	Generic Elective – I i. 8086 Microprocessor and Interfacing ii. Optoelectronics	4 hours	100	4
ELET-115	Research Methodology	1 hours	30	1
COM-100	***Constitution of India***	***2 hours***	***50***	***2***
ELEL- 121	Lab course 1 (based on ELET-111 and ELET-112)	6 hours	50	3
ELEL- 122	Lab course 2 (based on ELET-113 and ELET-114)	6 hours	50	3
ELER-131	Review of literature and Formulation of Topic for Research Project / Industry Project / Product Development	6 hours	50	3
Total Credits for Semester I : 28 (Theory : 19 ; Laboratory : 06, Research Projects : 03)				
Semester II (Core, Foundation and Generic Elective Courses)				
ELET -211	Embedded System –II (PIC Microcontroller)	4 hours	100	4
ELET -212	Microcontroller Interfacing	4 hours	100	4
ELET -213	Generic Elective – II i. Sensors and Actuators ii. Industrial Robotics iii. Signal Conditioning Circuits	4 hours	100	4
ELET -214	Generic Elective – III i. Advanced Sensor Technology ii. Industrial Processes and Instrumentation iii. Biomedical Instrumentation	4 hours	100	4
ELEL -221	Lab course 3 (based on ELET-211, ELET-212, ELET-213 and ELET-214)	6 hours	50	3
ELER -231	Research Project / Industry Project / Product Development Part I (Experimental Work)	12 hours	100	6
Total Credits for Semester II : 25 (Theory : 16 ; Laboratory : 03 ; Research Project : 06)				
Semester III (Foundation and Generic Elective Courses)				

ELET -311	Programmable Logic Controllers	4 hours	100	4
ELET -312	ARM Microcontroller	4 hours	100	4
ELET -313	Generic Elective – IV i. Applied Hydraulics and Pneumatics ii. PC Based Instrumentation iii. VLSI Design, Tools and Technology iv. Computational Modeling and Simulation	4 hours	100	4
ELET -314	Generic Elective – V i. Characterization Tools in Sensors ii. Industrial Networking iii. Kinetics and Dynamics of Robotics iv. Smart Fusion Technology Based System Design	4 hours	100	4
ELEL -321	Lab course 4 (based on ELET-311, ELET-312, ELET-313 and ELET-314)	6 hours	50	3
ELER -331	Research Project / Industry Project / Product Development Part II (Experimental Work)	18 hours	100	9
Total Credits for Semester III : 28 (Theory : 16 ; Laboratory : 03 ; Research Project : 09)				
Semester IV (Foundation, Generic and Open Elective Courses)				
ELET -411	Communication Technology	4 hours	100	4
ELET -412	Internet of Things (IoT)	4 hours	100	4
ELET -413	Generic Elective – VI i. Device Fabrication Technology ii. Flexible Manufacturing Technology iii. HMI, SCADA basics and Databases iv. Mixed Signal SoC Design	4 hours	100	4
OELE-101	Open Elective (from other Departments)	4 hours	100	4
ELEL -421	Lab course 5 (based on ELET-411, ELET-412 and ELET-413)	6 hours	50	3
ELER -431	Research Project / Industry Project / Product Development Part III (Organization and Interpretation of Results)	8 hours	100	4
ELER -432	Research Project / Industry Project / Product Development Part IV (Dissertation and Presentation)	4 hours	50	2
Total Credits for Semester IV : 25 (Theory : 16 ; Laboratory : 03 ; Research Project : 06)				
Total Credits : 106 (Sem I : 28 + Sem II : 25 : Sem III : 28 + Sem IV : 25)				

Preamble:

Dr. Babasaheb Ambedkar Marathwada University (Dr. B.A.M.U.) 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 Industrial Automation as specialized sector 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 by the year 2020 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 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 to be an Epitome of Excellence in Research & Development in the area of Sensor Technology, Semiconductor Devices, Mechatronics, and Industrial Communication 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 will –

- Provide a platform for the students with broad spectrum of diversity to achieve Academic Excellence with in-built Employability in the area of Sensor Technology, Semiconductor Devices, Mechatronics, and Industrial Communication.
- Establish a unique learning environment to enable the students to face the challenges in the area of Sensor Technology, Semiconductor Devices, Mechatronics, and Industrial Communication.
- 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 Sensor Technology, Semiconductor Devices, Mechatronics, and Industrial Communication 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, Mechatronics, and Industrial Communication 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, Mechatronics, and Industrial Communication for the solution of problems in complex electronics related problems.

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, Mechatronics, Industrial Communication and scientific literature.

PSO3. **Design Development of solutions :** Design / develop solutions for problems at varied complexity in the area Sensor Technology, Semiconductor Devices, Mechatronics, and Industrial Communication 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 modelling 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 Corse-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				√			√	√	√	√	√	√
ELER -231					√	√	√	√	√	√	√	√
ELET -311				√			√	√	√	√	√	√
ELET -312				√			√	√	√	√	√	√

ELET -313				√			√	√	√	√	√	√
ELET -314				√			√	√	√	√	√	√
ELEL -321				√			√	√	√	√	√	√
ELER -331	√	√	√		√	√	√	√	√	√	√	√
ELET -411				√	√	√	√	√	√	√	√	√
ELET -412				√			√	√	√	√	√	√
ELET -413				√			√	√	√	√	√	√
OELE-101							√					
ELEL -421					√	√	√	√	√	√	√	√
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 & 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	
IC001	2	2	Fully Attained	
ELER-131	3	2	Fully Attained	
ELEL-121	2	2	Fully Attained	
ELEL-122	0	2	Not Attained	Assignment, tutorials, exercise and Remedial coaching.
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	
ELER-231	0	2	Not Attained	Assignment, tutorials, exercise and Remedial coaching.
ELEL-221	3	2	Fully Attained	

Example of PO Attainment:

The attainment of PO will be calculated after declaration of IInd year result in the Month of April-2019.

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:

The first batch of M. Sc. Electronics is graduating in April 2019. The PO attainment for the corresponding batch shall be calculated on completion of the program.

Eligibility:

Candidates seeking admission to the first Semester of M.Sc. in Electronics must have passed B.Sc., (10 + 2 + 3) degree with Electronics as one of the optional subjects or have passed B. Sc.(Hons.) with electronics. Candidates who have appeared in the qualifying examination and their result is awaited, may appear in the Entrance Test on their own risk. They must submit a copy of the mark sheet to this office before declaration of results of the Entrance Test.

Course Fees:

Rs. 15,000/- per year.

Number of Seats: 25

The Intake capacity of M.Sc. Electronics will be 25 as under 'Self Finance Mode'

Admission / Promotion Process:

In response to the advertisement for registration, interested students will have to register themselves. 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.

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.

Choice Based Credit System (CBCS):

The choice based credit system is going to be adopted by this Centre. 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 102 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 CIA process in respective subject.

Departmental Committee:

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

Results Grievances / Redressal Committee

Grievances / redressal committee will be constituted in the department 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 test (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 semester end exam + 20

marks CIA) and 50 for 2 credit theory course (40 marks semester end exam + 10 marks CIA)

- Semester end examination (SEE) time table will be declared by the departmental committee (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. However, in case of non-availability of external examiner for either paper setting or assessment or both, department committee will be empowered to take appropriate decision.

- Pattern of semester end 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.

- The teacher who is teaching the particular course (paper) will be responsible for setting of question papers and evaluation for CIA as well semester end examination.

- After evaluation respective teacher will show answer scripts to the students and address the students grievances regarding evaluation of the respective courses.

- At the end of each semester the Departmental Committee will assign grades to the students. The result sheet will be prepared in duplicate.

- The Head of the Department shall send all results to the Controller of Examination for further processing.

- Applications from the students regarding examination related grievances will be discussed in the Departmental committee and examiners will be appointed accordingly.

- The results of students' grievances will be approved by Departmental committee and forwarded to Controller of Examination for further processing.

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	8.00-8.90	A^{++}	Exceptional
70-79	7.00-7.90	A^{+}	Excellent
60-69	6.00-6.90	A	Very Good
55-59	5.50-5.90	B^{+}	Good
50-54	5.00-5.40	B	Fair
45-49	4.50-4.90	C^{++}	Average (Above)
41-44	4.1-4.49	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. There will be no revaluation or recounting under this system.
- 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 details grades secured by the student in each subject in all semesters along with overall CGPA will be issued by the University at final exit.

M. Sc. (Electronics)

Semester I (Core and Foundation and Generic Elective Courses)

ELET – 111 Electronic System (4 credits)

Course Outcomes:

After completion of the course students will be able to -

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

Course Content:

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 (12 Hrs.)

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

References:

1. Sende, B.S. – Introduction to System design using Integrated Circuits, New Age International (P), NewDelhi.
2. Fitchen, F.C. – Integrated Circuits and Systems,Van Nostrand, New York.
3. 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 Power Electronics (4 credits)

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 Content:

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

Thyristor fundamental, 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 invertors. 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 **(12 Hrs.)**

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

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 Embedded system-I (4 credits)

Course outcomes:

After completion of the course students will be able to -

a) Design and develop automated system based on 8051 Microcontroller
b) Apply the basics of number system to solve arithmetic and logical operations of 8051 microcontroller.
c) Develop assembly language programming for 8051 microcontroller.
d) Analyse and debug assembly language programme for 8051 microcontroller

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 (12 Hrs.)

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

Unit IV: Jump and call instruction and applications (12 Hrs.)

Introduction, 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, application of 8051 microcontroller: simple programmers using 8051 microcontroller, display, generation of waves, pulse measurements, D/A and A/D conversion, stepper motor.

Unit V: (12 Hrs.)

Presentation, case studies, assignments, tutorials based on module I to IV

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 – 114 Generic Elective – I

i) 8086 microprocessor and interfacing (4 credits)

Course Outcomes:

After completion of the course students will be able to -

a) Compare and analyse Microprocessor architecture, physical configuration of memory, logical configuration of memory, microprocessor programming and interfacing.
b) Analyse the process of Industrial automation
c) Design automation system process of using 8086 microprocessor
d) Develop a manufacturing unit for microprocessor based automated devices.
e) Develop 8086 microprocessor programming for various industrial controls

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, program memory addressing modes: direct program memory addressing, relative program memory addressing, indirect program memory; 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 instruction: XCHG, IN and OUT, arithmetic and logic instructions: addition, subtraction and cmparison: 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 instruction: 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 controland miscellaneous instructions: contolling the carry flag bit, wait, HLT, NOP; Assembly language programming: assembler directiveds: 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 input 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, mode1 strobed input, mode 1 strobed output, mode 2 bisectional operation

Unit – V: (12 Hrs.)

Presentations, case studies, assignments, tutorials based on module 1 to 1V

References:

1. The Intel microprocessors, architecture programming and interfacing, Barry B Brey; sixth edition; prentice hall international, publications (2002)
2. The Intel microprocessors, architecture programming and interfacing, Barry B Brey; eight edition; prentice hall international, publications (2009)
3. Microprocessors and interfacing; programming and hardware, Douglas V Hall: II edition; Tata McGraw – Hill (1990)
4. Microcomputer systems: the 8086 / 8088 family, architecture, programming and design, Yu-Cheng Liu and Glenn A, Gibson, prentice hall international, publications (1986)
5. The 8086 / 8088 family: design, programming and interfacing, john, uffenbeck, prentice hall international, publications (1986)

ii) OPTOELECTRONICS (4 credits)

Course outcomes:

After completion of the course students will be able to -

a) Apply basic principles of optoelectronics for various applications
b) Describe the semiconductor optical amplifiers and their applications
c) Analyse various types of photodiodes, photo detectors
d) Evaluate the carrier loss and noise in photo detector using mathematical equations.

Course contents:

Unit – I: review of semiconductor device physics (12 Hrs.)

Energy bands in solids, the E-k diagram, density of states, occupation probability, Fermi level and quasi Fermi levels, pn junctions, schottky junction and ohmic contacts, semiconductor optoelectronic materials, band gap modification, heterostructures and quantum wells, interaction of photons with electrons and holes in a semiconductors; rates of emission and absorption, condition for amplification by stimulated emission, the laser amplifier

Unit – II: semiconductor photon sources (12 Hrs.)

Electroluminescence, the LED: device structure, materials and characteristics, the semiconductor laser, basic structure, theory and device characteristics: direct current modulation, quantum well laser; DFB, DBR and vertical cavity surface-emitting lasers (VCSEL); laser diode arrays, device packages and handling

Unit – III: semiconductor optical amplifiers and modulators (12 Hrs.)

Semiconductor optical amplifiers (SOA), SOA characteristics and some applications, quantum confined stark effect and electro absorption modulators

Unit – IV: semiconductor photodetectors (12 Hrs.)

Types of photodetectors, photoconductors, single junction under illumination: photon and carrier loss mechanisms, noise in photodectection; photodiodes, PIN diodes and APDs structures, materials, characteristics, and device performances, photo transistors, solar cells and CCDs, optoelectronics intergraded circuits – OEICs

Unit – V: (12 Hrs.)

Presentations, case studies, assignments, tutorials based on module 1 to 1V

Ref. books

1. B E A Saleh and M C Teich, fundamentals of photonics, John Wiley & sons, Inc., 2nd Ed. (2007) ch. 16, 17 and 18
2. P Bhattacharya, semiconductor optoelectronics devices, prentice hall of India (1997)
3. J Singh semiconductor optoelectronics: physics and technology, McGraw Hill Inc (1995)
4. G Keiser, optical fibre communications, McGraw Hill Inc 3rd Ed (2000) ch 4, 6
5. A Yariv and P Yeh, Photonics: optical electronics in modern communications, oxford university press, new York (2007), 6th Ed ch 15-17
6. J M Senior optical fibre communication principles and practice prentice hall of India 2nd Ed (1994) ch 6-8

ELET – 115 Research Methodology (01 Credit)

Course Outcomes:

After completion of the course students will be able to -

a) Compare and analyse research process
b) Do systematic literature survey, formulation of a research topic, study design, analysis and interpretation of data.
c) Design a research approach for a specific research issue of their choice.
d) Identify a suitable analytical method for a specific research approach.
e) Design and develop a research report.
f) Assess published quantitative research with regard to the statistical methods and approaches adopted
g) Create a research document for implementation research project

Course Content:

Unit I: Research Fundamentals: (3 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: (3 Hrs.)

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

Unit III: Formulation of Research Problem: (3 Hrs.)

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

Unit IV: Research Report and Proposal Writing: (3 Hrs.)

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

Unit – V: (12 Hrs.)

Presentations, case studies, assignments, tutorials based on module 1 to 1V

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

ELEL – 121
Lab course 1 (based on ELET – 111 and ELET – 112) – 3 Credits

List of Experiments:

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

(Student should submit one individual project employing OP-AMP and/or) power electronics

ELEL – 122
Lab course 2 (based on ELET – 113 and ELET – 114) – 3 Credits

List of Experiments:

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 for analog to digital converter interfacing using 8051 microcontroller.
5. Program to generate ramp, square. Triangular wave using DAC interfaced to 8051 microcontroller.
6. Program for interfacing stepper motor with 8051 microcontroller.
7. Data transfer, addition, subtraction, multiplication, and division using 8086 trainer.
8. Factorial and square of the number using 8086 trainer.
9. Sorting of data (Ascending/Descending), obtaining square root of number using 8086 trainer kit.
10. Arithmetic mean of N numbers and sum of square of Numbers using 8086 trainer kit.
11. Interfacing of SPDT switches and seven segment display as a position encoder/decoder to 8086 trainer kit.
12. Interfacing of stepper motor with 8086 trainer kit.
13. Interfacing of DC motor with 8086 trainer kit.
14. Interfacing of DAC with 8086 trainer kit to generate ramp wave, triangular wave, and square wave.
15. Interfacing of 8 bit ADC with 8086 trainer kit.
16. Interfacing of LCD display with 8086 trainer kit.

OR

7. Study of characteristics of photoconductive cell.
8. Study of characteristics of photovoltaic cell.
9. Study of characteristics of phototransistor
10. Study of characteristics of photodiode.
11. Determination of band gap of semiconductor
12. Study of hetero-junction diode.

ELER 131: Review of literature and Formulation of Topic for Research Project / Industry Project / Product Development 3 Credits

M.Sc. (Electronics)

Semester II (Core and Foundation and Generic Elective Courses)

ELET 211 Embedded Systems II-PIC Microcontroller (04 credits – 100 marks)

Course Outcomes:

After completion of the course students will be able to -

a) Describe the evolution of PIC Microcontroller and Embedded Processors
b) Evaluate the PIC 18 registers, determine the contents of file register and status register.
c) Analyze various instructions and addressing modes in PIC 18 microcontroller for arithmetic and logical programming.
d) Develop a simple arithmetic and logical program to interface peripherals with PIC 18 Microcontroller

Course Contents:

Unit– I: PIC Microcontrollers and Assembly Language Programming (12 Hrs.)

Introduction to PIC microcontrollers and embedded processors, Assembly Language Programming: WREG Register in PIC, PIC File Register, PIC Status register, PIC data format and directives, Introduction to PIC Assembly Programming: Structure of Assembly language, Assembling and linking a PIC Program, Program counter and program ROM space in the PIC, RISC architecture in PIC

Unit – II: Addressing Modes and Instruction Set (12 Hrs.)

Branch Instructions, Looping, Call instructions and Stack, PIC 18 Time delay and Pipeline concepts Arithmetic Instructions and operations, Logic and Compare Instructions, Rotate operation and Data serialization,

Unit – III: I/O programming and Interfacing (12 Hrs.)

Pin connection, PIC configuration registers, I/O port programming in PIC 18, I/O port bit manipulation programming
Real World device interfacing: LCD, ADC, DAC, Relay, Stepper Motor, DC motor

Unit – IV: Communication (12 Hrs.)

Types of Communication, Serial Communication, Parallel Communication Introduction of various Encoders & Decoders -Examples HT12E/HT12D. Interfacing circuits-Real time implementation using encoder/decoder Programming -Examples -Communication between two systems using RF module

Unit – V: (12 Hrs.)

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

References:

1. PIC microcontrollers and embedded systems- M.A. Mazidi, R. D. Mc. Kinlay, C, Causy; Pearsn, 2008, fourteenth impression ISBN-13: 978-0131194045 ISBN-10: 0131194046
2. Basic for PIC microcontrollers- N. Matic; webmaster, 2001
3. Getting started with arduino - Massimo Banzi, 2nd edition ISBN: 978-1-449-309879
4. Arduino notebook v1-1-Brian W Evans,1st edition
5. Intro Arduino Book- Alan G Smith, ISBN: 1463698348, ISBN-13: 978-1463698348
6. John B. Peatman, "Design with PIC microcontroller", McGraw Hill International Ltd., 1997

ELET 212 Microcontroller Interfacing (04 credits – 100 marks)

Course Outcomes:

After completion of the course students will be able to -

a) Design and develop various Microcontroller interfacing modules fir various applications.
b) Analyse the various ADC/DAC circuits and its importance in 8051 Microcontroller.
c) Design and develop a various circuit using 8051 microcontroller for interfacing remotely placed peripheral by applying basics in Serial communication.
d) Develop a low cost prototype using 8051 microcontroller to address frequently occurring problems in Industries.

Course contents:

Unit -I: Interfacing of Display Devices to 8051 (12 Hrs.)

Different types of display units - basic theory of the LED, Interfacing circuit of LED; 7 Segments & its types, Principle of Operation, Interfacing circuit of 7 segments; Basic theory of 16x2 LCD, Pin diagram of 16x2, working mechanism LCD using Arrays & Pointers, Interfacing of 16X2 LCD

Unit -II: DAC, ADC and sensor interfacing to 8051 (12 Hrs.)

Introduction to DAC, PIN Description for any standard DAC and its interfacing; Basic concepts of ADC interfacing, PIN Description of any standard ADC and its interfacing, Concept of Encoders and Decoders; Interfacing of sensors

Unit-III: Keypad and Motor interfacing to 8051 (12 Hrs.)

Keypad interfacing concepts, Standard Keypad interfacing; Relay interfacing concepts, Relay interfacing; DC motor interfacing concepts, DC motor interfacing; Stepper motor interfacing concepts; Stepper motor interfacing; Servo motor interfacing concepts, Servo motor interfacing

Unit -IV: Serial Communication and RTC interfacing with 8051 (12 Hrs.)

Concept of Serial Communication, Hardware Description of MAX 232, Interfacing of MAX 232 to 8051 and serial communication; Concept of RTC, Hardware Description of DS12887 RTC, Interfacing of DS12887 RTC to 8051

Unit - V: (12 Hrs.)

Tutorials, Assignments, Demonstrations and Presentation Based On Module I to IV

References:

1. M. A. Mazidi, J. G. Mazidi, and Rolin D. McKinlay; 2006; 8051 Microcontroller and Embedded Systems - using assembly and C; Pearson Education; ISBN-13: 978-01-311-9402-1

2. S. Ghosal; 2010; 8051 Microcontroller: Internals, Instructions, Programming and Interfacing; Pearson Education; ISBN 978-81-317-3143-7

3. James W. Stewart, Kai X. Miao; 1999; The 8051 Microcontroller: Hardware, Software, and Interfacing; Prentice Hall; ISBN 0-13-531948-X

4. S. Yeralan, A. Aluhwalia; 1993; Programming and Interfacing the 8051 Microcontroller; Addison-Wesley Publishing Company; ISBN 0-13-531948-X

ELET 213 Generic Elective-II

i) Sensors and Actuators
ii) Industrial Robotics
iii)Signal Conditioning Circuits

i) Sensors and Actuators (04 credits – 100 marks)

Course Outcomes:

After completion of the course students will be able to -

a) Compare and analyse Sensors and characteristics of sensors
b) Classify sensors and sensor systems
c) Analyse the system based on sensor and actuators.
d) Design and develop sensor devices
e) Test chemical and Physical 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 and Physical Sensors (12 Hrs.)

Introduction of light detectors: Photodiodes, Phototransistor, Photo resistors; photovoltaic cell, Optical waveguides and fibers, types of optical fibers: single mode, multimode and graded index optical fiber, concept of TIR and ATR, Optical fiber sensors: Introduction and classification of sensors with optical fibres. **Potentiometric Sensors;** Gravitational Sensors; LVDT and RVDT, Eddy Current Sensors, Piezoelectric sensors, Resistive Sensors: Potentiometers, Strain gages**;** Inductive sensors, capacitive sensors, Bridge circuits, Displacement Measurements,

Unit IV: Actuators (12 Hrs.)

Actuators: Actuation principle, Mechanical, Electrical, Fluid Power, Piezoelectric, Magnetostrictive, Shape memory alloy, applications, selection of actuators, Actuators in motor vehicles, power switches, electrical rotary and linear actuators.
- Electro-pneumatic and electro-hydraulic actuators for motor vehicles, pumps and valves.

Unit – V: (12 Hrs.)

Tutorials, Assignments, Demonstrations and Presentation Based On Module I to IV

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, Editedby Pavel Ripka and AloisTipek; 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)**

ii) Industrial Robotics (04 credits – 100 marks)

Course Outcomes:

After completion of the course students will be able to -

a) Apply basics principles of robotics for various Industrial applications
b) Apply various robotics command to develop codes for various applications.
c) Design and develop programs for robotic system by assembling robotic component.
d) Assess the Hazards and possible threats while dealing with the Robots in Industries to ensure safety.

Course Contents:

Unit I: Fundamentals of Robotics (12 Hrs.)

Introduction, Automation and Robotics, A brief History of Robotics, Robotics Market and the Future Prospectus

Unit II: Robot Programming (12 Hrs.)

Methods of Robot Programming, Lead through Programming Methods, Robot Program as path in space, Motion Interpolation, WAIT Signal and Delay Commands, Capabilities and Limitations of Lead through Methods; Robot Languages: Textual Robotic Languages, Generations of Robotic Programming Languages, Robot Language Structure, Motion Commands, Program Control and Subroutines, Monitor Mode Commands

Unit III: Robot Applications in Manufacturing (12 Hrs.)

Material Transfer and Machine Loading/Unloading, Processing Operation: spot welding, arc welding, spray coating, other processing operation using Robotics, Assembly and Inspection: Assembly and Robotic Assembly Operation, Inspection Automation

Unit IV: Implementation Principles and Issues of Robotics (12 Hrs.)

Implementation of Robotics; Safety Training and Maintenance and Quality Improvement; Social Issues and Future of Robotics

Unit V: (12 Hrs.)

Tutorials, assignments and presentation based on Module I to IV

References:

1. Tsuneo Yohikwa, Foundations of Robotics Analysis and Control, MIT Press. 2003.
2. John J. Craig, Introduction to Robotics Mechanics and Control, Third Edition, Pearson, 2008.
3. Bijay K. Ghosh, Ning Xi, T.J. Tarn, Control in Robotics and Automation Sensor – Based integration, Academic Press, 1999
4. Deb. S. R. "Robotics technology and flexible automation", Tata McGraw Hill publishing company limited, 1994
5. Industrial Robotics-Technology Programming and Applications by Mikell P Groover, Mitchell Weiss, Nagel and Odrey ISBN-13:978-0-07-026509-7 ISBN- 10: 0-07-026509-7
6. Richard D. Klafter, Thomas .A, Chri Elewski, Michael Negin, Robotics Engineering an Integrated Approach, Phi Learning., 2009.
7. 3. P.A. Janaki Raman, Robotics and Image Processing An Introduction, Tata Mc Graw Hill Publishing company Ltd., 1995.
8. Francis N-Nagy Andras Siegler, Engineering foundation of Robotics, Prentice Hall Inc., 1987.
9. Bernard Hodges, Industrial Robotics, Second Edition, Jaico Publishing house, 1993.

iii) Signal Conditioning Circuits (04 credits – 100 marks)

Course Outcomes:

After completion of the course students will be able to -

a) Describe the type of signal conditioning & its importance in electronic circuits.
b) Evaluate various terminologies used signal conditioning circuit.
c) Assess signal conditioning for specific applications.
d) 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: (12 Hrs.)

Presentation, case Studies, Assignments, Tutorial based on Module I to IV

References:

1. Paul Horowitz, Winfield Hill, “The Art of Electronics”, 2 nd Ed., Cambridge University press, 2008.
2. Andrew Parr, “ Industrial Control hand book”, 3 rd 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” 2 nd ed. Wiley-Interscience 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”, 3 rd ed., Newnes Industrial Press, 2000

i) Advanced Sensor Technology
ii) Industrial Process and Instrumentation
iii) Biomedical Instrumentation.

i) Advanced Sensor Technology : (04 credits – 100 marks)

Course Outcome:

After completion of the course students will be able to –

a) Classify sensor materials and technologies.
b) Analyse the system based on sensor and actuators.
c) Design experiments for sensor calibration
d) Develop sensor devices and sensor networks.
e) 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: **(12 Hrs.)**

Presentation, case Studies, Assignments, Tutorial based on Module I to IV

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)**

ii) Industrial Processes and Instrumentation (04 credits – 100 marks)

Course Outcomes:

After completion of the course students will be able to –

a) Describe the various terminologies in control systems
b) Analyse the results obtained from instruments to take appropriate action
c) Understand various indicators in industrial process instrumentation
d) Design flow charts various operations in process control.

Module -1: Introduction to Industrial Control Systems (12 Hrs.)

Classification of Control System, Industrial Control System, Elements of Open and Close Loop Control System, Feedback Control, Dynamic Response of a Closed Loop System, Control System Parameters

Module -2: The Controller Operation (12 Hrs.)

Block Diagram, Algebra Of Control System, Concept Of Process Control, Automatic Controllers – Analog And Digital, Control Modes- On-Off, Proportional Control, Integral Control, Derivative Control, PID Control, Time Proportioning Control, Time Proportioning Circuit

Module -3: Industrial Process Techniques (12 Hrs.)

Batch Process, Continuous Process, Instrumentation, Measurement Devices, Feedback Loop Interface Instruments, Controllers

Module – 4: Industrial Process Instrumentation (12 Hrs.)

Monitoring Instruments - Indicators, Alarms and Recorders. Manipulation Devices- The Control Valve, the Valve Body, Instrumentation Symbology- General Instrument Symbol, Tag Numbers, Line Symbols, Valve and Actuators Symbols

Module – 5: (12 Hrs.)

Tutorials, Assignments, Demonstrations and Presentation Based On Module I To IV

iii) Biomedical Instrumentation (04 credits – 100 marks)

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.

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 (12 Hrs.)

Biochemical sensors - pH, Po_2 and Pco_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 (12 Hrs.)

Presentation, case Studies, Assignments, Tutorial based on Module I to IV

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 Courses 3 (3 Credits)

(Based on ELET-211, ELET 212, ELET 213 and ELET 214)

ELEL 221 Lab course 3 (BASED ON ELET 211 Embedded System II)

List of experiments:

1. Study interfacing of Relay with PIC microcontroller
2. Study interfacing of LCD with PIC microcontroller
3. Study interfacing of ADC with PIC microcontroller
4. Study interfacing of DAC with PIC microcontroller
5. Study interfacing of DC motor with PIC microcontroller
6. Study interfacing of Stepper motor with PIC microcontroller
7. Study interfacing of DAC and DC motor with PIC microcontroller
8. Study interfacing of LED with PIC microcontroller

(At least six experiments from above list should be performed.)

ELEL 221 Lab course 3 (BASED ON ELET 212 Microcontroller Interfacing)

List of experiments:

1. Study the interfacing of LED with 8051 microcontroller
2. Study the interfacing of Seven segment display with 8051 microcontroller
3. Study the interfacing of LCD with 8051 microcontroller
4. Study the interfacing of Relay with 8051 microcontroller
5. Study the interfacing of ADC with 8051 microcontroller
6. Study the interfacing of DAC with 8051 microcontroller
7. Study the interfacing of Stepper motor with 8051 microcontroller
8. Study the interfacing of Servo motor with 8051 microcontroller
9. Study the interfacing of DC motor with 8051 microcontroller
10. Study the interfacing of Keypad with 8051 microcontroller

(Any six experiments should be performed from following list)

ELEL 221 Lab course 3 (BASED ON ELET 213 Sensors and Actuators)

List of experiments:

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 Displacement sensor
7. Study of Potentiometric 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

(Any six experiments should be performed from following list)

ELEL 221 Lab course 3 (BASED ON ELET 213 Industrial Robotics)

List of Experiments:

1. Develop simple programs to define pre-coordinated trajectory of robots
2. Develop program for pick and place operation with a six axis industrial robot
3. Develop program for stacking operation with a six axis industrial robot
4. Develop program for picking an object from predefined position of ASRS and placing it in a pneumatic vice with a five axis industrial robot.
5. Develop program for emulating a welding operation with a six axis industrial robot.
6. Offline Programming: The modeled robot is programmed offline, also using the industrial robot simulation system
7. Programming a parallel kinematic robot for a palletizing application.
8. External TCP and Moving Base / Frame Coordinate Calibration
9. Program using external TCP and Moving Base / Frame
10. Loop Programming of Industrial Robot
11. Interrupt Programming of Industrial Robot

(Any six experiments should be performed from following list)

ELEL 221 Lab course 3 (BASED ON ELET 213 Signal Conditioning Circuits)

List of experiments:

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.

(Any six experiments should be performed from following list)

ELEL 221 Lab course 3 (BASED ON ELET 214 Advanced Sensor Technology)

List of experiments:

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)

(Any six experiments should be performed from following list)

ELEL 221 Lab course 3 (BASED ON ELET 214 Industrial Processes & Instrumentation)

List of Experiments:

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

(At least six experiments from above list should be performed.)

ELEL 221 Lab course 3 (BASED ON ELET 214 Biomedical Instrumentation)

List of Experiments:

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. Analysis of bio signals using spectrum analyzer.
10. Study of characteristics of optical Isolation amplifiers.

(At least six experiments from above list should be performed.)

ELER 231: Research Project / Industry Project / Product Development Part I (Experimental Work) (6 Credits)

M.Sc. (Electronics)

Semester III (Foundation and Generic Elective Courses)

ELET 311 Programmable Logic Controllers (04 credits – 100 marks)

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: (12 Hrs.)
Presentations, case studies, Assignments, Tutorials based on Unit I to IV.

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 ARM Microcontroller (04 credits – 100 marks)

Course Outcomes:

After completion of the course students will be able to –

a) Describe various architectural features of ARM.
b) Analyze RISC, CISC, instruction sets, pipe-lining concepts.
c) Develop a logical program using basic instructions to interface I/O devices
d) Design a simple system application using ARM microcontroller.

Course Contents:

Unit– I: Basics of ARM Microcontroller (12 Hrs.)

Architectural block diagram, features, Architectural features of different types of architectures used in Microcontrollers, like Van Neumann, Harvard, CISC, RISC, SISC architectures. Special features like watchdog timer, clock monitor, On-chip flash program memory, On-chip static RAM, Compiler, Emulation and Debugging, applications of ARM

Unit – II: ARM Organization (12 Hrs.)

8,16,32 bit and floating point numbers processing, format conversion between Hex, BCD, ASCII, data movement/copy operations,3-stage pipeline ARM organization, 5-stage pipeline ARM organization, PLL. Reset and Wake-up Timer, Brownout detector, Code Security, External Interrupt input, Memory Mapping Control, Power Control, VPB, ARM instruction execution, ARM implementation, The ARM coprocessor interface.

Unit – III: ARM Instruction Set (12 Hrs.)

ARM instruction set-Branch, branch with link(B,BL),branch, branch with link and exchange(BX,BLX),software interrupt(SWI),data processing instructions, multiply instructions, multiple register transfer instructions, Co-processor instructions. Block transfer of data, data swap/exchange, Arithmetic, logical, and stack operation, loops, condition evaluation and decision making based on flags, control transfers (Call, Return, Jumps), processor state changing (ARM THUMB),Interrupts and Its Handling.

Unit – IV: Architectural Support for System development (12 Hrs.)

The ARM memory interface, The Advanced Microcontroller Bus Architecture (AMBA), The ARM reference peripheral specification Hardware system prototyping tools, The ARM ulator, The JTAG boundary scan test architecture, The ARM debug architecture, ARM processor Cores-ARM7TDMI,ARM8,Interfacing Light Emitting Diodes, 7-segment display, 16X2 LCD, GLCD, keypad, stepper motor and Analog to Digital Converter to ARM Controller.

Unit – V: (12 Hrs.)

Presentations, case studies, Assignments, Tutorials based on Unit I to IV

References:

1. Microcontroller: Architecture, implementation and Programming by Kenneth Hintz and Daniel Tabak, Tata McGraw Hill.
2. ARM Assembly Language: “Fundamentals and Techniques” Second Edition by William Hohl and Christopher Hinds
3. Embedded Systems: Introduction to Arm(r) Cortex(tm)-M Microcontrollers: 1; Jonathan Valvano
4. Steave Furber, “ARM system – on – chip architecture”, Addison Wesley, 2000
5. Daniel Tabak, “Advanced Microprocessors”, McGraw Hill. Inc., 1995

ELET 313 Generic Elective -IV (04 credits – 100 marks)

i. Applied Hydraulics and Pneumatics
ii. PC Based Instrumentation
iii. VLSI Design, Tools and Technology

i) Applied Hydraulics and Pneumatics

Course Outcomes:

After completion of the course students will be able to –

a) Describe the key aspects and physical properties used in hydraulics and pneumatics
b) Describe the functionality, advantages, disadvantages and applications of valves, servos and motors.
c) Analyse the results, draw the graphs after performing hydraulic and pneumatic experiments
d) Analyse the possible failure that may occur in Hydraulic and pneumatic systems.

Course Contents:

Unit-I: Hydraulic Servo Techniques and Hydrokinetics (12 Hrs.)

Overview of function of hydraulic system, properties of Hydraulic fluids, general types of fluids, fluid power symbols, Mechanical feedback and application of tracer valve, Feedback in the system, Electro-hydraulic servo systems, Torque Motors, Types of Servo valves, Special valve features, Terminologies in servo technology. Types of transmission, pump-motor combination, Applications of Hydraulic transmission.

Unit-II: Design of Hydraulic Systems (12 Hrs.)

Hydraulic circuits, Manual and automatic hydraulic systems, application of Pascals Law, Laminar and Turbulent flow. Regenerative ckt., use of check valves, pump classification, Gear pump, Vane pump, Piston pump, construction and working of pump, selection of pump, Circuit Diagram standards, basic circuits functional diagram, application of functional diagram, electrical control of hydraulic systems.

Unit-III: Fluidics and Hydro-pneumatics (12 Hrs.)

Introduction to fluidics, Bistable flip flop, turbulence amplifier, low pressure, pneumatics sensors, application of fluidics/ low pressure pneumatics as sensors proportional devices, Hydro pneumatics systems, hydraulic check Modules, hydro pneumatic cylinder, fluid power actuators: Types of Hydraulic cylinders-Single acting ,Double acting cylinders parallel check Module, integral air-oil, cylinder, types of feed, intensities, comparison of hydro pneumatics, hydraulic and hydro pneumatics system.

Unit-IV: Automation and Principle of Pneumatic circuit design (12 Hrs.)

Pneumatic controls, Compressors – Filter, Regulator, Lubricator Unit – Air control valves, Quick exhaust valves, pneumatic actuators Functional diagram in pneumatic circuit design, Movement diagram, Cascade system in pneumatic circuit design, Logics in pneumatic circuit design, Logics and Boolean algebra. Demorgans theorem of inversion. Examples of control equation, use of K-V map for pneumatic circuit design, K-V diagram and Control problem

Unit-V: (12 Hrs.)

Tutorials, assignments and presentation based on Unit I to IV

References:

1. S. R. Majumdar – Oil Hydraulic Systems: Principles and Maintenance, Tata McGraw Hill Education Pvt. Ltd., ISBN – 0-07-463-748-7
2. W. Bolton – Pneumatic and Hydraulic Systems, Butterworth Heinemann, ISBN – 0-07-506-383-62
3. A. Parr – Hydraulics and Pneumatics: A Technician‘s and Engineer‘s Guide, Butterworth Heinemann, ISBN – 0-08-096-674-8
4. S R Maunder; 2006 (Sixteenth Reprint); Pneumatic Systems (Principal and maintenance); Tata McGraw - Hill Publishing Company Limited; ISBN 0-07-460231
5. P. Joji; 2008; Pneumatic Controls; Willey India Pvt. Ltd., ISBN 978-81-265-1542-4
6. Antony Barber; 1997 (Eighth Ed.); Pneumatic Handbook; Elsevier Science Ltd.; ISBN 978-81-265
7. Andrew Parr; 2011 (Third Ed.); Hydraulics and Pneumatics-A Technician’s and Engineer’s Guide; Elsevier Ltd. (Butterworth-Heinemann); ISBN-13: 978-0-08-0966748

ii) PC Based instrumentation

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

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.

iii) VLSI Design, Tools and Technology

Course Outcomes:

After completion of the course students will be able to –

a) Draw and explain simple and complex logic gates in CMOS.
b) Describe the process of IC fabrication
c) Derive and describe the current voltage equations, characteristics of MOSFETs
d) Design and simulate NAND, NOR gate and draw their transient response.

Course Contents:

Unit – I: Introduction to VLSI (12 Hrs.)
Complexity and Design, Basic concepts, Ideal switches and Boolean operations, MOSFETs as switches, Basic logics gates in CMOS, complex logic gates in CMOS, Transmission Gate circuits, Clocking and data flow control.

Unit – II: Internal Structure and Fabrication of ICs (12 Hrs.)
Integrated Circuit layers, MOSFETs, CMOS layers, Designing FET arrays, Overview of silicon processing, Material growth and deposition, Lithography, The CMOS process flow, Design rules.

Unit - III: Aspects of Physical Design And Electrical (12 Hrs.)

Basic concepts, Layout of basic structures, Cell concepts, FET sizing and the unit transistor, Physical design of logic gates, Design hierarchies, MOS physics, nFET current-voltage equations, FET RC model, pFET characteristics, Modelling of small MOSFETs.

Unit – IV: Analysis and Designing of CMOS Logic Gates (12 Hrs.)
DC characteristics of the CMOS inverter, Inverter switching characteristics, Power dissipation, DC characteristics: NAND and NOR gates, NAND and NOR transient response, Analysis of complex logic gates, Gate design for transient performance, Transmission gates and pass transistors.
Designing High-speed CMOS Logic Networks- Gate delays, Driving Large capacitive loads, Logical effort, Bi-CMOS drivers.

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

References:

1. S.K. Ghandhi, “VLSI Fabrication principles”, 2/e, John Wiley & Sons (Asia) Pte. Ltd., 2003.
2. S.M. Sze, “VLSI Technology”, 2/e, McGraw-Hill, 1988.
3. N.H.E. Weste and K. Eshraghian, “Principles of CMOS VLSI design”, Pearson Education, Inc., 1999.
4. Yuan Taur and T.H. Ning, “Fundamentals of Modern VLSI devices”, Cambridge University Press, 1998.
5. R.L. Geiger, P.E. Allen and N.R. Strader, “VLSI design Techniques for Analog and Digital Circuits”, McGraw-Hill, 1990.

ELET 314 Generic Elective -V (04 credits – 100 marks)

i. Characterization tools in Sensors
ii. Industrial Networking
iii. Kinetics and Dynamics of Robotics

i) Characterization tools in Sensors

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

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: (12 Hrs.)

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

References:

1. Elements of X-ray Diffraction B. D. Cullity, Addison Wesley, 1977
2. Transmission Electron Microscopy: A Textbook for Materials ScienceDavid 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.

ii) Industrial Networking

Course Outcomes:

After completion of the course students will be able to –

a) Describe hardware, software components of network and its applications.

b) Describe industry open protocol, its applications their advantages and disadvantages.

c) Troubleshoot common network and control issue.

d) Design and establish a wireless network using Zigbee and Bluetooth modems

Course Contents:

Unit-I: Introduction to Networks and Various Communication Protocols (12 Hrs.)

An Introduction to Networks in process automation: Information flow requirements, Hierarchical communication model, Data Communication basics, OSI reference model, Industry Network, Introduction to Communication Protocols: Communication basics, Network Classification, Device Networks, Control Networks.

Unit -II: Network Architectures (12 Hrs.)

Proprietary and open networks: Network Architectures, Building blocks, Industry open protocols (RS-232C, RS- 422, and RS-485), Ethernet, Advantages and Limitations of Open networks, IEEE 1394 LAN Connectivity; Bridges, Routers and Switches, Ethernet Industrial Protocol (Ethernet/IP), Industrial Adaptations to Ethernet, Modem Types and Features.

Unit -III: Modbus-Field Bus architecture (12 Hrs.)

Field bus: Field bus Trends, Hardware selection, Field bus design, Installation, Documentation, Field bus advantages and limitations. HART: Introduction, Design, Installation, calibration, commissioning.

Unit -IV: Planning and Commissioning (12 Hrs.)

Foundation Field bus & Profibus: Introduction, Design, Calibration, Commissioning, Application in Hazardous and Non-Hazardous area. Introduction to wireless Protocols: WPAN, Wi-Fi, Bluetooth, ZigBee, Z-wave.

Unit -V: (12 Hrs.)

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

Ref. Books:

1. B.G. Liptak - Process Software and Digital Networks - CRC Press ISA-, 2002.
2. R. Bowden - HART Communications Protocol-Fisher-Rosemount, 2003.
3. A.S. Tanenbaum -Computer Networks - Pearson Education, 1996/PHI.
4. K. Kant – Computer based Process Control – New Age International, 1998

ii) Kinematics and Dynamics of Robotics

Course Outcomes:

After completion of the course students will be able to –

a) Describe the principles of Kinematics and Dynamics of Robotics and its applications
b) Evaluate the safety issues while dealing with the Robots in various applications
c) Describe the principles of Robot programming and design a Robotic system for a simple task
d) Design and develop robotics control circuits for various applications

Course Contents:

Unit-I Introduction to Robotics and Elements of Robots (12 Hrs.)

Introduction – brief history, types, classification and usage, Science and Technology of robots, parameters and link transforms, Representation of joints, link representation using D-H parameters different kinds of actuators –stepper, DC servo and brushless motors, model of a DC servo motor, Types of transmissions, Purpose of sensors, internal and external sensors, common sensors – encoders, tachometers, strain gauge based force-torque sensors, proximity and distance measuring sensors, and vision.

Unit-II Kinematics of Robots (12 Hrs.)

Introduction, Direct and inverse kinematics problems, Examples of kinematics of common serial manipulators, workspace of a serial robot, Inverse kinematics of constrained and redundant robots, Tractrix based approach for fixed and free robots and multi-body systems, simulations and experiments, Solution procedures using theory of elimination, Inverse kinematics solution for the general 6R serial manipulator.

Unit-III Dynamics of Robots (12 Hrs.)

Mass and inertia of links, Lagrangian formulation for equations of motion for serial and parallel manipulators, Generation of symbolic equations of motion using a computer, Simulation (direct and inverse) of dynamic equations of motion, Examples of a planar 2R and four-bar
Mechanism, Recursive dynamics, commercially available multi- body simulation software (ADAMS) and Computer algebra software Maple.

Unit –IV Motion Planning and Control (12 Hrs.)

Joint and Cartesian space trajectory planning and generation, Classical control concepts using the example of control of a single link, Independent joint PID control, Control of a multi-link manipulator, Non- linear model based control schemes, Simulation and experimental case studies on serial and parallel manipulators, Control of constrained manipulators, Cartesian control, Force control and hybrid position/force control, Advanced topics in non-linear control of manipulators

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

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

References:

1. Ghosal, A., Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2nd reprint, 2008.
2. Fu, K., Gonzalez, R. and Lee, C.S. G., Robotics: Control, Sensing, Vision and Intelligence , McGraw- Hill,1987.
3. M.W. Spong, S. Hutchinson and M. Vidyasagar, Robot Modeling and Control, Wiley, 2006.
4. K. S. Fu, R. C. Gonzalez and C. S. G. Lee, Robotics - Control, Sensing, Vision, and Intelligence, McGraw-Hill Book Company, 1987.

ELEL 321 Lab course 4 (BASED ON ELET 311 Programmable Logic Controller)

List of Experiments:

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

ELEL 321 Lab course 4 (BASED ON ELET 312 ARM Microcontroller)

List of Experiments:

1. Study of Interfacing of LED with ARM
2. Study of Interfacing of 16x2 LCD with ARM
3. Study of Interfacing of Buzzer with ARM
4. Study of Interfacing of Relay with ARM
5. Study of Interfacing of ADC with ARM
6. Study of Interfacing of DAC with ARM
7. Study of Interfacing of Seven segment with ARM

ELEL 321 Lab course 4 (BASED ON ELET 313 Applied Hydraulic and Pneumatics)

List of Experiments:

1. Design of a hydraulic circuit with servo valve
2. Design and construction of a hydraulic circuit with proportional valve
3. Design and construction of a pneumatic sequencing circuit
4. Design and construction of a pneumatic circuit with quick exhaust valve
5. Design and construction of a pneumatic circuit with time delay valve
6. Design and construction of a pneumatic speed control circuit
7. Design and construction of Hydraulic regenerative circuit
8. Design and construction of Hydraulic Punch and Drill circuit

ELEL 321 Lab course 4 (BASED ON ELET 313 PC Based Instrumentation)

List of Experiments:

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.

ELEL 321 Lab course 4 (BASED ON ELET 313 VLSI Design, Tools and Technology)

List of Experiments:

1. Study of basic logic gates in CMOS.
2. Study of Photolithography Technique.
3. Study of FET array design
4. Study of I-V characteristics of MOSFET.
5. Study of nFET and pFET characteristics.
6. Study of DC characteristics of CMOS invertor.

ELEL 321 Lab course 4 (BASED ON ELET 314 Characterization Tools in sensors)

List of Experiments:

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

ELEL 321 Lab course 4 (BASED ON ELET 314 Industrial Networking)

List of Experiments:

1. Study of Network topologies.
2. Study of TCP/IP reference model.
3. Study of OSI reference model.
4. Study of Field bus and HART.
5. Study of Zigbee Network.
6. Study of Bluetooth Network.

ELEL 321 Lab course 4 (BASED ON ELET 314 Kinematics and Dynamics of Robotics)

List of Experiments:

1. Study of Robot (Industrial grade e.g. KUKA/ FANUC etc.)
2. Mastering of Robot
3. Study of various Co-ordinate system of Robot
4. Adjusting position of Robot
5. Programming of robot for Linear Motion
6. Programming of robot for Circular Motion
7. Programming of Robot for various applications

ELER: 331: Research Project / Industry Project / Product Development Part II
(Experimental Work) (9 Credits)

M.Sc. (Electronics)

Semester IV (Foundation and Generic Elective Courses)

ELET 411: Communication Technology

(04 credits – 100 marks)

Course Outcomes:

a. On completion of the course, students should be able to-
b. Identify the issues and challenges in the architecture of computer network
c. Explain the concept of communication model, OSI reference model, Recent Industry Networks.
d. Classify the Network selection applicable for specific industrial needs.
e. Differentiate the Network Architecture and describe the concepts of Industrial protocols.
f. Classify and Compare various Wireless Networking protocols

Course Contents:

UNIT-I: Introduction and Communication Protocols (12 Hrs.)

An Introduction to Networks in process automation: Information flow requirements, Hierarchical communication model, Data Communication basics, OSI reference model, Industry Network, Introduction to Communication Protocols: Communication basics, Network Classification, Device Networks, Control Networks.

UNIT-II: Network Architectures (12 Hrs.)

Proprietary and open networks: Network Architectures, Building blocks, Industry open protocols (RS-232C, RS- 422, and RS-485), Ethernet, Advantages and Limitations of Open networks, IEEE 1394

UNIT-III: Field Bus (12 Hrs.)

Field bus: Field bus Trends, Hardware selection, Field bus design, Installation, Documentation, Field bus advantages and limitations. HART: Introduction, Design, Installation, calibration, commissioning.

UNIT-IV: Planning and Commissioning (12 Hrs.)

Foundation Field bus & Profibus: Introduction, Design, Calibration, Commissioning, Application in Hazardous and Non-Hazardous area. Introduction to wireless Protocols: WPAN, Wi-Fi, Bluetooth, ZigBee, Z-wave.

UNIT-V: **(12 Hrs.)**

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

References:

1. B.G. Liptak - Process Software and Digital Networks - CRC Press ISA-, 2002.
2. R. Bowden - HART Communications Protocol-Fisher-Rosemount, 2003.
3. A.S. Tanenbaum -Computer Networks - Pearson Education, 1996/PHI.
4. K. Kant – Computer based Process Control – New Age International, 1998

ELET 412 Internet of Things (IoT)

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

Course Contents:

UNIT- I: Introduction to 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 (12 Hrs.)

Protocol Standardization for IoT, M2M and WSN Protocols, SCADA and RFID Protocols Issues with IoT Standardization, BACNet Protocol, Modbus, KNX, Zigbee Architecture Network layer, APS layer, Key elements of IoT, Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination

UNIT -III: IoT Devices and Security Challenges (12 Hrs.)

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, Security: Identity establishment, Access control, Data and message security, Non-repudiation and availability, Security model for IoT, Other challenges.

UNIT-IV: Design, Implementation and Application of IoT. (12 Hrs.)

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

UNIT-V: (12 Hrs.)

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

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 413 Generic Elective –VI (4 Credits: 100 Marks)

i) Device Fabrication Technology
ii) Flexible Manufacturing Technology
iii) HMI, SCADA basics and Databases

i) Device Fabrication Technology

Course Outcomes:

a) Apply the basic knowledge in Microelectronic fabrication technique
b) Know the fundamental challenges in fabrication technique
c) Differentiate and analyze tradeoffs in processing parameters to optimize process parameters
d) 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: **(12 Hrs.)**

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

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.

ii) Flexible Manufacturing Technology

Course Outcomes:

a. State the basic concepts of FMS, cell, JIT, KANBAN system and CMM
b. Classify and compare different types of FMS, machining centers, Kanban, CMM, AGVS, AS/RS; also differentiate between FMS and FMC
c. Illustrate area of applications of a FMS, CMM, JIT, various equipments and their functions required for an FMS.
d. Analyze the reasons for adopting group technology, analyze the AGV Systems, AS/RS as well as distinguish between Axes and Format of Machining Centers, Horizontal and Vertical Machining Centers
e. Explain the visual inspection aspects

Course Contents:

UNIT– I: Introduction to FMS (12 Hrs.)

Introduction and Definition, Basic Components of FMS, The Significance of FMS in the 1990s, Different Types of FMS, Types of FMS Layouts, Factors Influencing the FMS Layouts, Seeking Benefits on Flexibility, FMS—An Example of Technology and an Alternative Layout, Objectives of an FMS, Aims of FMS, The Principle Objectives of FMS, Advantages and Disadvantages of FMS Implementation, Advantages and Disadvantages of FMS, Area of Application of a FMS in Industry, Various Equipments and their Functions Required for an FMS, Innovations that have Advanced the Manufacturing Industries, CIM Technology, Hierarchy of CIM, Direct Real Time Schedule Control, FMS Concepts

Introduction of manufacturing cell, Definition of Cell, Classification of Cell, Unattended Machining, Differences between FMC and FMS

UNIT – II: JIT, KANBAN System, and Group Technology (12 Hrs.)

Introduction and Definition, Big JIT, Little JIT, JIT Concept, Goals of JIT, JIT Reality, Objectives of JIT, JIT Ingredients, Quality and Quantity Principles of JIT, the Primary Quantity JIT Principles, Benefits of JIT, JIT Implementation, Introduction to Kanban/Card System, Push vs. Pull System, Types of Kanban, Introduction , Definition, Reasons for Adopting Group Technology, Visual Inspection , Part Classification and Coding, Production Flow Analysis , Benefits of Group Technology Affecting Many Areas of a Company, Obstacles to Application of GT.

UNIT– III: FMS Elements – I (12 Hrs.)

Machining Centers: Introduction, Types of Machining Centers , Machining Center Innovations and Developments, Axes and Format of Machining Centers, Horizontal and Vertical Machining Centers, Automated Features and Capabilities of Machining Centers.

Coordinate Measuring Machines: Introduction, CMM Construction, Probe, Mechanical Structure, Types of CMM, Functions of CMM Computer, Operational Cycle Description, CMM Applications, CMM Advantages

UNIT– IV: FMS Elements – II **(12 Hrs.)**

Automated Material Movement and Storage System: Introduction, Types of AGVS, Unit Load Carriers, ASRS Systems, Analysis of AGV Systems, Automated Storage and Retrieval Systems (AS/RS), Unit Load AS/RS, Mini Load AS/RS, Carousel AS/RS, Advanced Automated Storage and Retrieval System, Analysis of AS/RS, Quantitative Analysis, Industrial Robots Case Studies

UNIT - V: **(12 Hrs.)**

Tutorials, assignments and presentation based on Module I to IV

References:

1. Flexible Manufacturing System Author : H. K. Shivanand, M. M. Benal, V. Koti Publisher : New Age Pub. ISBN-10: 8122418708 ISBN-13: 978-8122418705
2. Automation, Production Systems and Computer Integrated Manufacturing by Author : Groover M.P
3. Approach to Computer Integrated Design and Manufacturing Author : Nanua Singh Publisher : John Wiley and Sons ISBN-13: 978-0471585176 ISBN-10: 0471585173
4. Principles Of Computer - Integrated Manufacturing, Author : Vajpayee, S K Book Code : 9788120314764
5. Flexible Manufacturing Cells and Systems Author : Luggen ISBN-13: 978-0133217384 ISBN-10: 0133217388
6. Ian Gibson 2009, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer [ISBN: 9781441911193]
7. Serope Kalpakjian 2013, Manufacturing Engineering & Technology., 7th Ed., Pearson [ISBN: 9780133128741]

iv) HMI, SCADA basics and Databases

Course Outcomes:

a. On completion of the course, students should be able to –
b. State the basic features of SCADA, HMI
c. Develop architecture of SCADA and explain the importance of SCADA in critical infrastructure.
d. Analyze the theory and applications of SCADA
e. Develop projects with SCADA and HMI
f. Implementation of SCADA application.

Course Contents:

UNIT – I: Project Development and HMI (12 Hrs.)

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

UNIT– II: SCADA System (12 Hrs.)

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

UNIT–III: SCADA Protocols (12Hrs.)

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: **(12 Hrs.)**

Tutorials, assignments and presentation based on Module I to IV

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]

ELEL 421 Lab course 5 (BASED ON ELET 411 Communication Technology)

List of Experiments:

1. Study of 7 Layer OSI reference model
2. Study of Industry open protocol – RS 232
3. Study of Zigbee Technology
4. Study of Ethernet protocol
5. Study of Fieldbus Protocol
6. Study of profibus protocol

ELEL 421 Lab course 5 (BASED ON ELET 412 Internet of Things)

List of Experiments:

1. Study of physical and soft component in a IOT System
2. Shell scripting programming for IOT
3. Study of Python programming
4. Hardware (Sensors and Actuators) interfacing protocol for IOT
5. Study of Communication protocols (at least 2)
6. System development for agriculture/ ambient atmospheric condition

ELEL 421 Lab course 5 (BASED ON ELET 413 Device Fabrication Technology)

List of Experiments:

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. Photoresist coating and pattern transfer by photolithography technique
6. SiO2 coated Silicon thin film characterization using Grazing Incidence X –ray diffraction (GIXRD)
7. X –ray Micro diffraction study of materials coated between microelectrodes

ELEL 421 Lab course 5 (BASED ON ELET 413 Flexible Manufacturing Technology)

List of Experiments:

1. Study of different parts of a flexible color sorting station
2. Experiment with retrieval of modular work pieces from cartridge assembly
3. Experiment with linear transport station
4. Sorting of finished products on basis of their shape/ contour.
5. Sorting of finished products on basis of their material of construction
6. Sorting of finished products on basis of their color

ELEL 421 Lab course 5 (BASED ON ELET 413 HMI, SCADA basics and Databases)

List of Experiments:

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

OELE-101 Open Elective (from other Departments) (4 Credits)

ELER-431 Research Project / Industry Project / Product Development Part III (Organization and Interpretation of Results) (4 Credits)

ELER-432 Research Project / Industry Project / Product Development Part IV (Dissertation and Presentation) (2 Credits)