
# CURRICULUM & SYLLABI

## DEPARTMENT
## OF
## ELECTRONICS ENGINEERING

## (Session 2016-17)

# B. TECH (ELECTRONICS ENGG.)
# COURSE STRUCTURE

# ABOUT THE DEPARTMENT

The Department of Electronics Engineering was established in 1988. It has made significant progress since its inception and attained the status of a pioneering Department particularly in the Faculty of Engineering and Technology and in general in the University. The department has credit of being first department in the faculty of Engineering & Technology to have the Departmental Research Support (DRS) scheme funded by UGC. Currently Phase-II of this scheme is running in the department.

The Department offers an undergraduate (B. Tech.) course in Electronics Engineering and two postgraduate (M. Tech.) courses in (1) Electronic Circuits & Systems Design and (2) Communication & Information System. The subjects offered at both, UG & PG levels cover almost all upcoming and areas of significance viz. Analog & Digital Electronics, Microelectronics, VLSI Design & Technology, Electronic Instrumentation, Control Systems, Analog & Digital Communications, Microwave Engineering, Radio, Television, Radars, Optical Communication, Satellite Communication, Mobile Communication, Computer Communication Networks, Image and Signal processing, etc. The well-equipped laboratories supplement a large number of these courses.

Beside UG & PG programmes the Department encourages research activities in the emerging areas and provides facilities for the same. In addition, the faculty members are also working in collaboration with universities abroad on joint research projects. Also some faculty members regularly visit abroad for collaborative research. The Teaching Staff of the Department has supervised a good number of Ph. D. theses and M. Tech Dissertations since its inception. The Department offers five prestigious Visvesvaraya Ph. D. fellowships to its students.

# VISION AND MISSION OF THE INSTITUTE

## VISION

To become an institute of excellence in scientific and technical education and research with standards at par with national and international institutes of repute and to serve as quality human resource provider to the society and industry.

## MISSION

1. To offer state-of-the-art undergraduate, postgraduate and doctoral programmes.
2. To make policies and atmosphere to attract and retain best faculty.
3. To create an ambience in which new ideas and cutting-edge research flourish through effective curriculum and infrastructure so as to produce the leaders and innovators tomorrow.
4. To produce ethically strong and morally elevated human resource to serve mankind.
5. To undertake collaborative projects and consultancy for long term interaction with the academia and industry.
6. To be among top ten engineering institutes of India by 2017.

# VISION AND MISSION OF THE DEPARTMENT

**VISION**

To produce quality engineers and scientist capable of providing sustainable solutions for complex problems and promoting cost effective, indigenous technology for all sections of society.

**MISSION**

1. To frame a well-balanced curriculum with emphasis on basic theoretical knowledge as well the requirements of the industry.
2. To motivate students to develop innovative solutions for the betterment of the society.
3. Collaboration with the industry, research establishments and other academic institutions to bolster the research and development activities.

# B. TECH. PROGRAM

# ELECTRONICS ENGG.

# LIST OF FACULTY MEMBERS

| S.No. | Name | Qualification | University | Teaching Experience | Period | Date of Joining | Specialization |
|---|---|---|---|---|---|---|---|
| 1. | Dr Zia A Abbasi | Ph. D. | AMU | Asst. Prof.<br>Assoc. Prof.<br>Professor | 09.03.1982<br>07.01.1987<br>27.07.1998 | 09.03.1982 | Communication Systems, Digital Signal Processing |
| 2. | Dr Pervez Mustajab | Ph. D. | IIT Roorkee | Asst. Prof.<br>Assoc. Prof.<br>Professor | 08.02.1984<br>17.03.1989<br>27.07.1998 | 08.02.1984 | Digital Systems, Microprocessors, Intelligent Instrumentation, Fuzzy Logic |
| 3. | Dr Mirza Salim Beg | Ph. D. | Loughborough University, UK | Asst. Prof.<br>Assoc. Prof.<br>Professor | 28.06.1984<br>11.11.1991<br>16.11.2003 | 28.06.1984 | Wireless Networks, Multimedia Communications, Computer Networks, Consumer Electronics |
| 4. | Dr Mohd Hasan | Ph. D. | University of Edinburgh, UK | Asst. Prof.<br>Assoc. Prof.<br>Professor | 14.03.1992<br>19.03.1997<br>19.03.2005 | 14.03.1992 | VLSI Design, Nano-electronics, Embedded System |
| 5. | Dr Omar Farooq | Ph. D. | Loughborough University, UK | Asst. Prof.<br>Assoc. Prof.<br>Professor | 28.09.1992<br>30.10.2002<br>01.01.2009 | 28.09.1992 | Signal Processing, Speech Recognition, Biomedical Signal Processing |
| 6. | Dr. M Shah Alam | Ph. D. | Queen's University of Belfast, UK | Asst. Prof.<br>Assoc. Prof.<br>Professor | 11.01.1993<br>12.12.2002<br>01.01.2009 | 11.01.1993 | RF Circuits and Systems Design, Nano-electronics |
| 7. | Dr Ekram Khan | Ph. D. | University of Essex, UK | Asst. Prof.<br>Assoc. Prof.<br>Professor | 07.07.1993<br>03.04.2003<br>13.03.2009 | 07.07.1993 | Communication Systems, Signal Processing, Image/Video Coding, Biomedical Image Processing, Image/Video Transmission |
| 8. | Dr S Maheshwari | Ph. D. | AMU | Asst. Prof.<br>Assoc. Prof.<br>Professor | 02.09.2000<br>30.10.2007<br>30.10.2013 | 02.09.2000 | Analog Signal Processing Circuits, Current Mode Circuits |
| 9. | Dr S Javed Arif | Ph. D. | AMU | Asst. Prof.<br>Assoc. Prof.<br>Professor | 28.08.1997<br>28.08.2010<br>10.04.2014 | 28.08.1997 | Electronic Circuits and System Design, Instrumentation and Measurement |
| 10. | Dr M J Siddiqui | Ph. D. | IIT Kanpur | Asst. Prof.<br>Assoc. Prof.<br>Professor | 11.10.1988<br>19.03.1997<br>29.01.2015 | 11.10.1988 | Semiconductor Device Modeling, Microelectronics and VLSI Design |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 11. | Dr S A Rahman | Ph. D. | IIT Delhi | Asst. Prof.<br>Assoc. Prof.<br>Professor | 11.10.1988<br>19.03.1997<br>29.01.2015 | 11.10.1988 | Electronic Circuits, Artificial Neural Networks |
| 12. | Dr A A Moinuddin | Ph. D. | AMU | Asst. Prof.<br>Assoc. Prof.<br>Professor | 12.05.1997<br>12.05.2010<br>29.01.2015 | 12.05.1997 | Communication Systems, Wireless Communication Image/Video Coding |
| 13. | Dr (Mrs) T Parveen | Ph. D. | AMU | Asst. Prof.<br>Assoc. Prof. | 02.09.1986<br>19.03.1997 | 02.09.1986 | Electronic Circuits and Systems Design, Analog Signal Processing Circuits |
| 14. | Mr M Raza Abidi | M Sc. Engg | AMU | Asst. Prof.<br>Assoc. Prof. | 19.02.1988<br>19.03.1997 | 19.02.1988 | Finite Field Algebra, Fiber Optic Signal Processing Wireless Communication, Coding Theory |
| 15. | Dr Anwar Sadat | Ph. D. | AMU | Asst. Prof.<br>Assoc. Prof. | 06.08.2001 | 06.08.2001 | Instrumentation and Measurement |
| 16. | Dr M Samar Ansari | Ph. D. | AMU | Asst. Prof. | 01.05.2015 | 01.05.2015 | Analog VLSI, Artificial Neural Networks |
| 17. | Dr Naushad Alam | Ph. D. | IIT Roorki | Asst. Prof. | 24/05/2016 | 24/05/2016 | Robust Nanoscale Circuit Design,<br>SRAM Cell for Low Power, Delay Models |
| 18. | Dr Mohd Sharique | Ph. D. | IIT Kanpur | Asst. Prof. | 24/05/2016 | 24/05/2016 | Communication Theory<br>Broadband Wireless Communication |
| 19. | Mr Mohd Wajid | M. Tech. | IIIT Hyderabad | Asst. Prof. | 18/06/2016 | 18/06/2016 | Signal Processing, VLSI |
| 20. | Mr Javed S Malik | M. Tech. | MS, TUM Germany | Asst. Prof. | 25/06/2016 | 25/06/2016 | Wireless and Mobile Communication |
| 21. | Dr M Ayyub Khan | Ph. D. | AMU | Asst. Prof. | 30/07/2016 | 30/07/2016 | Image/Video Coding<br>Video Communication |
| 22. | Ms Raziya Shamim | M. Tech. | AMU | Asst. Prof. | 02/08/2016 | 02/08/2016 | Communication System<br>Signal Processing<br>Wireless Sensor Network |

# ORDINANCES (ACADEMIC) CHAPTER - XXXIV (F)

**Bachelor of Technology in the Faculty of Engineering & Technology**
**(Effective from the Session 2011 – 2012)**

**1. Introduction**

(a) The Faculty of Engineering & Technology, Aligarh Muslim University offers full-time program leading to the Bachelor of Technology (B. Tech.) degree in Chemical Engineering, Civil Engineering, Computer Engineering, Electrical Engineering, Electronics Engineering, Mechanical Engineering, and Petrochemical Engineering.
(b) The medium of instruction in B. Tech. Program is English.

**2. Eligibility**

A candidate will be eligible for admission to B. Tech. program if he/she has passed the Senior Secondary School Certificate (10+2) Examination of this University or an Examination recognized by this University as its equivalent with 50% marks in aggregate of English, Physics, Chemistry, and Mathematics, or have passed the Diploma in Engineering Examination of this University with 50% marks in aggregate.

**3. Admission**

(a) The admissions to the B. Tech. programs will be made normally in the Autumn Semester as per the admission policy approved by the Academic Council of the University from time to time. The admission of each student will be made in a particular branch.
(b) A limited number of students may be allowed to change over from one branch of study to another, after first year of study, depending on the availability of seats and their performance in the first two semesters.

**4. Academic Session**

The academic session is divided into two regular semesters – Autumn and Winter, each of which shall be of approximately 20 weeks duration. The Autumn semester will normally commence in the month of July/August every year, and the Winter in the month of December/January. In the beginning of every session the Dean, in consultation with the Chairmen of the departments concerned, shall notify a detailed academic calendar indicating the schedule of teaching, examination, and other activities.

**5. Duration of the Program**

**5.1 Minimum Duration**

The minimum duration of the program shall be eight consecutive semesters after admission.

**5.2 Maximum Duration**

The maximum duration of the program shall be fourteen consecutive semesters after admission.

**6. Curriculum and Credit System**

**6.1 Credit System**

Each B. Tech. program will have a curriculum in which every course will be assigned certain credits reflecting its weight and contact periods per week, as given below:

1 Lecture period (L) per week = 1 Credit
1 Tutorial period (T) per week = 1 Credit
1 Practical period (P) per week = 0.5 Credit

In addition to theory and laboratory courses there may be other courses such as seminar, colloquium, project, etc., which will be assigned credits as per their contribution in the program without regard to contact periods.

### 6.2 Course Categories

The curriculum for each branch will contain courses in the following categories having credits in the ranges given below in such a way that the total of all credits will be equal to that required for the award of degree as specified elsewhere in these ordinances.

**(a)** Basic Sciences (BS) 20-36 credits
(Courses such as Physics, Chemistry, Mathematics etc.)

**(b)** Engineering Sciences & Arts (ESA) 20-40 credits
(Foundation and applied engineering courses that are used across many branches)

**(c)** Humanities and Management (HM) 10-18 credits (Language, Social science, & Management)

**(d)** Departmental Core (DC) 60-116 credits

**(e)** Departmental Electives (DE) 16-32 credits

**(f)** Open Electives (OE) 8-16 credits

### 6.3 Coordinators and Curriculum Development Committee

There shall be a Chief Coordinator, B. Tech. Programs, to be nominated by the Dean, and a Coordinator, B. Tech. Program for each branch in each department, to be nominated by the Chairman of the department concerned. Normally the Chief Tabulator will be the Chief Coordinator, B. Tech. Programs. There shall also be a standing Curriculum Development Committee (CDC), to be constituted by the Faculty. The Chief Coordinator, B. Tech. Programs will be the Convener of the CDC.

### 6.4 The Curriculum Structure

The curriculum for each branch will contain a listing of all courses, with each course having a course category, course number, course title, number of contact periods per week, number of credits assigned, and the marks assigned to various components of evaluation. It will also have a list of alternative courses in the new curriculum for the old curriculum courses and filler courses to compensate for the shortfall in credits earned by taking alternative courses in any category, if needed. It will also specify all other conditions required for the award of degree.

### 6.5 Approval of the Curriculum

The curriculum for each branch of B. Tech. program will be prepared by the department concerned and will be approved by the Board of Studies of the department. It will then be vetted by the CDC and will then be placed in the Faculty along with the recommendations of the CDC for approval. Once approved by the Faculty, the Curriculum will be implemented. The same procedure shall be used for any modification in the Curriculum.

## 7. Registration

### 7.1 Registration Procedure and Schedule

**(a)** Every student is required to register, in each semester, for the courses that he/she wants to pursue in that semester. The registration schedule will be announced by the Dean/Chairman for every semester. The registration process involves:

(i) Submitting a registration form in the office of the Chairman and obtaining a registration card signed by the Chairman;
(ii) Paying the required fees.

**(b)** A student will normally register for higher semester courses only if he has also registered for uncleared courses of previous semesters, especially in the case of un-cleared courses of first two semesters.

**(c)** A student will have the option to add/delete/alter the courses in his/her registration within a week of the registration subject to such conditions as may be imposed by the department concerned from time to time.

**(d)** A student can drop a course from his/her registration by submitting a request to his/her department coordinator up to a date specified on his/her registration card. A registered course will be counted as an attempt even if the student remains absent in the Examination(s).

**(e)** No student will be allowed to register for more than 40 credits in a semester. A graduating course, however, will not be included in this limit.

**(f)** A student may be denied registration in a course due to reasons of paucity of staff or space or other facilities, especially in case the student is registering a course for improving the grade in a passed course.

**(g)** If a student fails to register in two consecutive semesters without specific permission from the Dean, his/her name may be removed from the rolls of the faculty. Such a student may apply to the Dean for re-admission stating the reasons for not being able to register for two consecutive semesters and the Dean will take suitable decision on the merit of the case.

### 7.2 Graduating Course

A student may be allowed to register for one course of not more than 5 credits if he/she is able to graduate by passing such a course, irrespective of whether the course is being offered in the current semester to regular students or not, provided that the student has fulfilled the attendance requirement earlier and has been awarded E or I grade in that course. Such a course shall be known as a graduating course.

## 8. Attendance (In lieu of Chapter XVII of the Academic Ordinances)

Attendance in each course separately is compulsory at least once. Students who have put in 75% or more attendance in a course in a semester will be eligible to appear in the End-Semester Examination of that course. Students who have put in 65% or more but less than 75% attendance in a course may be considered for condonation of shortage of attendance in that course by the condonation committee. Students whose attendance in a course is less than 65% or whose shortage in attendance has not been condoned will not be eligible to appear in the End-Semester Examination of that course and will be awarded grade ‘F’ in that course and all marks obtained in any component of the course-evaluation will stand cancelled. However, in case a student is repeating a course and the student has already fulfilled the attendance requirement in that course, he/she will not be detained due to shortage of attendance in that course during the repeating semester.

## 9. Examination and Evaluation (In lieu of Clause (9) of Chapter XV of the existing Academic Ordinances)

### 9.1 Components of Evaluation

Each course will be evaluated out of 100 marks. The courses will normally have the following components of evaluation:
**(a)** Theory courses:

Course work 15 marks
Mid-Semester Examination 25 marks
End-Semester Examination 60 marks

**(b)** Laboratory courses including Seminar, Colloquium, Project, etc.
Course work 60 marks
End-Semester Examination 40 marks

However, for special academic reasons, some courses may have different weight for different components of evaluation from that given above. Such special reasons will be spelt out clearly in the curriculum.

**9.2 Grading System**

The combined marks obtained by a student in various components of evaluation of a course shall be converted into regular letter grades with their equivalent grade points as specified below Grade points Description
A 10 Outstanding
B 8 Very good
C 6 Good
D 4 Satisfactory (Minimum Pass Grade)
E 2 Unsatisfactory (Fail)
F 0 Detained due to shortage of attendance
I 0 Incomplete/Absent in the End-Semester Examination
Z 0 Cancelled due to other reasons
The following marks ranges may ordinarily be used for the award of grades to the students in a course.

| Range | Grade |
|---|---|
| 75 and above | A |
| 60 and above but less than 75 | B |
| 45 and above but less than 60 | C |
| 35 and above but less than 45 | D |
| Less than 35 | E |

Two grace marks may be awarded by the examiner for passing a course and one grace mark may be awarded by the examiner to elevate the grade. Any fraction in any component of evaluation should be rounded off to the next whole number.

The examiner(s) may propose higher or lower grade ranges depending upon the nature of the course and general performance of the students in the course, but the final decision rests with the Result Moderation Committee. However, the minimum passing grade `D` should never be awarded if a student secures below 35 marks (including 2 grace marks) in a course.

**9.3 Evaluation of a Graduating Course**

A graduating course shall be evaluated on the basis of the End-Semester Examination component of the course alone. The student shall appear only in the End-Semester Examination of the graduating course. Grade D shall be awarded if the student concerned obtains 35 or more of the marks allotted to End-Semester Examination alone. In case the marks obtained are less than 35, grade E will be awarded. Two grace marks, however, will be awarded for passing the course.

**9.4 Earned Credits (EC)**

If a student passes a course by obtaining grade D or above he/she earns the credits assigned to that course.

**9.5 Performance Indices**

At the end of every semester a student's performance will be indicated by Earned Credits (EC), a Semester Performance Index (SPI), and a Cumulative Performance Index (CPI). The SPI is the credit-weighted average of grade points of all courses registered during a semester and is computed as follows:

**SPI = (C1G1 + C2G2 +……) / (C1 + C2 +…….)**

Where C1, C2… are the credits assigned to courses and G1, G2 … are the grade points earned in those courses. The CPI is the credit-weighted average of grade points of all courses passed in all the semesters since admission.

**9.6 Repetition of a Failed Course**

If a student fails in a course his/her marks of all components of evaluation in that course will be cancelled. The student will have to register the course again or its alternative and will be required to appear in all components of evaluation afresh. No previous marks shall be used in any case.

**9.7 Repetition of a Passed Course**

A student may repeat a course to try to improve his/her grade in that course only once, provided that he/she has passed that course in a single attempt. In such case the student will have to register the course again and will be required to appear in all components of evaluation afresh. No previous marks shall be used in any case. For the purpose of calculating the SPI the recently obtained grade will be considered while for CPI the better of the two grades will be counted.

**9.8 Conduct of Examinations**

**(a)** The examiners for the End-Semester Examination of all theory courses will normally be the teacher(s) associated with the course. The Seminar, Colloquium courses will be examined by the teacher(s) associated with the course and one or more examiners from among the teachers of the department to be recommended by the BOS of the department concerned. The laboratory and project courses will be examined by the teachers(s) associated with the course and an external examiner not in the service of the university at the time of examination. In case the external examiner does not turn up for the examination, the Chairman of the department concerned, in consultation with the course in-charge, shall call another person to act as the external examiner, even from within the University, if necessary.

**(b)** The End-Semester Examination of all graduating courses shall be conducted simultaneously along with the End-Semester Examination of regular courses of the current semester examination.

**9.9 Moderation Committees**

**(a)** Question Paper Moderation Committee: There shall be a Moderation Committee of the concerned Department consisting of the following members to moderate the Question Papers of the End-Semester Examination.

(i) Chairman of the Department concerned – (Convener)
(ii) One senior teacher of the Department in each broad area of specialization (to be appointed by the BOS).

**Note:** The Paper Setter(s) may be invited, if necessary, to clarify the necessary details of the question paper.

**(b)** Result Moderation Committee: There shall be a Result Moderation Committee of the concerned Department consisting of the following members to moderate course-wise results of the End-Semester Examinations.

(i) Chairman of the Department concerned - (Convener)
(ii) One senior teacher of the Department in each broad area of specialization (to be appointed by the BOS).
(iii) Examiner(s) concerned.

The Result Moderation Committee will examine the result of each theory course and in case of an abnormal situation; it may take suitable corrective measures in consultation with the examiner(s). The examiner(s) will place the evaluated answer scripts along with the brief solution and marking scheme before the Committee. In case of difference of opinion among the members of the Committee, the majority decision will prevail, in which the examiner(s) will not participate.

**10. Degree Requirement**

**(a)** A student who earns 200 credits subject to the break up in various course categories and fulfills such other conditions as may be mentioned in the curriculum will be awarded the degree of Bachelor of Technology. He/she must also pay all University dues as per rules. Moreover, there should be no case of indiscipline pending against him/her.

**(b)** If a student earns more credits than the minimum required for the award of degree, his/her CPI will be calculated by considering the best grades subject to fulfilling the criteria of required credits as specified in the curriculum.

**11. Name Removal from the Rolls of the University and Mercy Appeal**

**11.1 Name Removal**

The earned credits (EC) of every student will be checked at the end of even number of semesters and if the total credits earned by the student are less than the minimum required as given below, his/her admission to the B. Tech. program will be cancelled and his/her name will be removed from the rolls of the University.

| Check Point (No. of semesters after admission) | Minimum EC requirement |
|---|---|
| 2 semesters | 0 |
| 4 semesters | 25 |
| 6 semesters | 50 |
| 8 semesters | 80 |
| 10 semesters | 110 |
| 12 semesters | 140 |
| 14 semesters | 200 |

**11.2 Mercy Appeal**

If the name of a student is removed from the rolls of the University as per provisions of clause 11.1 of these ordinances, he/she may appeal to the Vice-Chancellor stating the reasons for not being able to earn the required credits and the Vice-Chancellor, if he is satisfied with the reasons, may allow the continuation of admission of the student only once during the tenure of the program, extending the total duration of the program by two semesters, at the maximum, beyond 14 semesters, if required. Under no circumstances a student will be allowed to complete the program after the lapse of 16 semesters after admission.

**12. Result**

**(a)** If a student passes all the examinations and fulfills all the requirements for the award of degree his/her result will be shown as “Graduated”.

**(b)** The Division awarded to “Graduated” students will be based on CPI as given below:
First Division (Honours) **CPI _>8.5**
First Division **6.5 < CPI < 8.5**

Second Division **CPI < 6.5**
There shall be no formula for conversion of CPI or SPI into equivalent percentage of marks during the program. However, once the program is completed by a student and he/she is graduated, his/her final CPI will be converted into equivalent percentage of marks by the following formula:

$$y = (20x^3 - 380x^2 + 2725x - 1690)/84$$

Where y is the percentage of marks and x is the CPI.

**(c)** If a student earns more credits than the minimum required as given in the table in clause 11.1 before fulfilling the degree requirements, his/her result will be shown as "Continued".

**(d)** If the name of a student is removed from the rolls of the University as per provisions of clause 11.1 of these ordinances his/her result will be shown as "Name Removed".

**(e)** Ranks/Positions will be determined at the end of even semesters. Only those students who fulfill the following conditions will be eligible for ranks/positions:

(i) They do not have any break in their studies;
(ii) They have passed every scheduled course in first attempt;
(iii) They have passed every course on time as per the curriculum;
(iv) They have earned credits as per the schedule given in the curriculum;
(v) They have not improved grade in any course after passing the course.

The students who violate any of the above conditions will not be awarded any rank/position. The ranks/positions will be determined on the basis of CPI.

13. **Transitory Ordinance**
Candidates admitted prior to the implementation of these Ordinances shall be governed by the Ordinances (Academic) under which they were admitted. Students who fail in the courses that are no more offered in these new ordinances and new curriculum will be allowed to pass the alternative courses, and in case there are no alternative courses, the old courses may be offered. For such candidates, any marks obtained earlier shall not be taken into account for passing the course(s) and they will have to obtain marks in all components of evaluation afresh. A student admitted previously may apply to the Dean through the Chairman concerned, to be governed by these ordinances. Such cases may be allowed on a case by case basis.

# REGULATIONS TO CHAPTER XXXIV (F) OF ORDINANCES (ACADEMIC) FOR B. TECH. DEGREE PROGRAM

**1. Explanations**

**1.1 Course Number**

Every course has a course number consisting of 5 characters (minimum) and 6 characters (maximum). The first two characters are alphabets indicating the department that offers or coordinates the course; the third character is a numerical digit indicating the ear of offering the course in the program; the fourth character is a numerical digit indicating the type of course; the fifth character is a numerical digit that does not indicate any particular thing; and the sixth character is optional.

(a) The first two alpha characters will mean the following:

AC = Department of Applied Chemistry
AM = Department of Applied Mathematics
AP = Department of Applied Physics
AR = Department of Architecture
CE = Department of Civil Engineering
CH = Department of Chemical Engineering
CO = Department of Computer Engineering
EE = Department of Electrical Engineering
EL = Department of Electronics Engineering
ME = Department of Mechanical Engineering
PK = Department of Petroleum Studies
EZ = Departments external to Z.H. College of Engineering & Technology

(b) The third character will be 1, 2, 3, or 4 indicating First Year, Second Year, Third Year or Fourth Year of the B. Tech. program.

(c) The fourth character will be interpreted as follows:

1-7 = Theory courses
8 = Courses such as Seminar, Colloquium, Field work, etc.
9 = Laboratory/Practical courses and Projects.

**1.2 Faculty Number**

Every student has a Faculty number consisting of 8 characters. The first two characters are numerical digits indicating the year of admission; the third and fourth characters are alphabets indicating the branch of the B. Tech. program; the fifth character is always “B” indicating B. Tech. program; the sixth, seventh and eighth characters are numerical digits that are for identifying a student of a particular batch.

(a) The first two characters will be the right most two digits of the year of admission. Thus students admitted in 2011 will have the first two characters as 11.

(b) The third and fourth characters will be interpreted as follows:

CE = Civil Engineering

EE = Electrical Engineering
KE = Chemical Engineering
LE = Electronics Engineering
ME = Mechanical Engineering
PE = Computer Engineering
PK = Petrochemical Engineering

(c) In case of change of branch after First year, a student's faculty number will be changed as required.

**1.3 Marks**

(a) The combined total marks obtained by a student in the course work and the mid-semester examination will be called Sessional Marks.

(b) The marks obtained by a student in the end-semester examination will be called Examination Marks.

**2. Conduct of Teaching**

**2.1 Course In-charge**

Every course will be taught by one or more teachers. The BOS of the concerned department will allocate the teaching load to the teacher(s) and will also designate a course in-charge for each course. If more than one department is involved in the teaching of the course, the course in-charge will be from the coordinating department. The course in-charge will coordinate all the work related to attendance, course work, examination and evaluation. It is necessary that the students are informed about the course incharge so that they may contact him/her about any problems regarding the course.

**2.2 Display of Attendance, Marks etc.**

It is essential that the attendance should be displayed to the students twice in a semester, once in the middle and then at the end of a semester by the teacher(s) concerned. The mid-semester marks should be displayed to students normally within 15 days of the examination. The total sessional marks should be displayed to the students before the beginning of the end-semester examinations. The course in-charge will ensure that the teachers associated with the course make such displays and, in case of complaints from the students in this regard, shall inform the Chairman of the concerned department about the problem.

**2.3 Offering Courses**

(a) Courses will be offered by the department concerned as per the schedule given in the relevant Curriculum. Departments may also offer a course in both the semesters even though it may be shown in a particular semester.

(b) Department Elective (DE) courses will be offered depending on the availability of the staff and other facilities and therefore any particular elective course may not be offered even though it may exist in the list of possible elective courses.

(c) The advisement for Open Elective (OE) courses in various departments will be based on the guidelines approved by the respective Board of Studies.

**2.4 Syllabus**

Each course will have a syllabus which will be distributed to the students. The teacher(s) concerned should ensure that some portion, beyond the syllabus, should also be covered in the class.

**3. Correction of Errors**

In case any error is detected in the marks recorded on the award list, the examiner(s) concerned shall make a request to correct the mistake to the Dean, Faculty of Engg. & Tech. through the Chairman of the concerned department, and shall attach relevant documentary evidence. A committee consisting of the following members shall take suitable remedial measures depending upon the merit of the case.

1. Dean, Faculty of Engg. & Tech. (Chairman)
2. Principal, ZH College of Engg. & Tech.
3. Chairman of the concerned department.
4. One senior member of the Faculty, not belonging to the concerned department, to be nominated by the Dean.
5. Chief Tabulator, B. Tech. Program.

**4. Examinations**

**4.1 Mid-Semester Examination**

Mid-semester examination(s) of each course will be of one hour duration and will be conducted as per norms and schedule notified by the office of the Dean in each semester.

**4.2 End-Semester Examination**

End-semester examination(s) of each theory course shall be of three hours duration and will be conducted as per norms and schedule notified by the Controller of Examination of the University on the advice of the Dean. The end-semester examinations of laboratory/practical courses, and other courses such as seminar, colloquium, field work and project etc. shall be conducted as notified by the Dean/Chairman concerned.

**4.3 Make-up Test**

Students who miss the Mid-Semester Examination in a course due to illness or some other extra-ordinary compelling situation may contact the teacher(s) concerned of the course with the request to conduct a make-up test. The teacher(s) shall follow the guidelines in this regard approved by the Faculty from time to time. There shall be no make-up test/examination for end-semester examinations.

# PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

1. To produce Electronics engineering graduates with sound theoretical knowledge for better employability.
2. To develop analysis and design skills to solve complex engineering problems, independently as well in a team.
3. To train graduates in the use of relevant computer-based tools.
4. To provide motivation for the exposure to challenging research problems.

# PROGRAM OUTCOMES (POS)

a. Capability of applying knowledge of mathematics, basic sciences, and engineering to solve Electronics engineering problems.

b. Formulation and analysis of engineering problems using concepts of mathematics and engineering sciences.

c. Ability to provide design solutions for intricate engineering problems suited to the needs of society.

d. To draw conclusions based on the design of experiments, analysis and interpretation of data.

e. Creation and application of suitable models of complex systems using modern techniques and software tools.

f. Understanding of and commitment to professional and ethical responsibilities.

g. Understanding the effect of engineering solutions on society and environment for sustainable growth.

h. Ability to work independently as well as with diverse teams.

i. Development of effective written and oral communication skills.

j. Ability to manage engineering projects effectively.

k. Ability of independent thinking and lifelong learning.

# B. TECH (ELECTRONICS ENGINEERING.) COURSE STRUCTURE

**First Semester (Effective for the students from the session 2011 – 12)**

| S.No. | Course Category | Course No. | Course Title | Periods/week | | | Credit | Course Work Marks | Mid-Sem. Exam Marks | End Sem. Univ. Exam Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | | |
| 1 | BS | AC-111 | Applied Chemistry | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 2 | BS | AM-111 | Applied Mathematics – I | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 3 | ESA | ME-101 | Basic Thermal Sciences | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 4 | ESA | EE-111 | Basic Electrical & Electronics Engg. | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 5 | BS | AC-194 | Applied Chemistry Lab | 0 | 1 | 2 | 2 | 60 | - | 40 |
| 6 | ESA | CO-191 | Computer Programming Lab | 0 | 1 | 2 | 2 | 60 | - | 40 |
| 7 | ESA | ME-193 | Engineering Graphics Lab | 1 | 0 | 2 | 2 | 60 | - | 40 |
| | | | **Total** | **13** | **6** | **6** | **22** | | | |

**Second Semester (Effective for the students from the session 2011 – 12)**

| S. No. | Course Category | Course No. | Course Title | Periods/week | | | Credit | Course Work Marks | Mid-Sem. Exam Marks | End Sem. Univ. Exam Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | | |
| 1 | BS | AP-111 | Applied Physics | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 2 | BS | AM-112 | Applied Mathematics – II | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 3 | HM | EN-101 | English | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 4 | ESA | CE-111 | Environmental Studies | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 5 | ESA | ME-111 | Mechanics & Strength of Material | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 6 | BS | AP-194 | Applied Physics Lab | 0 | 1 | 2 | 2 | 60 | - | 40 |
| 7 | ESA | ME-194 | Manufacturing Process Lab | 0 | 1 | 2 | 2 | 60 | - | 40 |
| | | | **Total** | **15** | **7** | **4** | **24** | | | |

**Third Semester (Effective for the students from the session 2012 – 13)**

| S.No. | Course Category | Course No. | Course Title | Periods/week | | | Credit | Course Work Marks | Mid-Sem. Exam Marks | End Sem. Univ. Exam Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | | |
| 1 | BS | AM-251 | Higher Mathematics - I | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 2 | BS | AM-252 | Higher Mathematics - II | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 3 | DC | EL-211N | Electronic Devices & Circuits | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 4 | DC | EL-212 | Circuit Theory | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 5 | DC | EL-222 | Electronic Instrumentation | 3 | 1 | - | 4 | 15 | 25 | 60 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 6 | DC | EL-241 | Signals and Systems | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 7 | HM | EZ-291 | Communication Skills Lab | - | 1 | 2 | 2 | 60 | - | 40 |
| 8 | DC | EL-296 | Electronics Lab - I | - | 1 | 2 | 2 | 60 | - | 40 |
| | | | **Total** | **18** | **8** | **4** | **28** | | | |

## Fourth Semester (Effective for the students from the session 2012 – 13)

| S. No. | Course Category | Course No. | Course Title | Periods/week | | | Credit | Course Work Marks | Mid-Sem. Exam Marks | End Sem. Univ. Exam Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | | |
| 1 | ESA | EE-202N | Electrical Engineering | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 2 | ESA | AP-204 | Electromagnetics | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 3 | DC | EL-223 | Control Systems | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 4 | DC | EL-231 | Logic Circuits | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 5 | DC | EL-242 | Principles of Communication Engineering | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 6 | DC | EL-213 | Analog Electronics | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 7 | DC | EL-298 | Instrumentation Lab | - | 1 | 2 | 2 | 60 | - | 40 |
| 8 | DC | EL-297 | Electronics Lab - II | - | 1 | 2 | 2 | 60 | - | 40 |
| | | | **Total** | **18** | **8** | **4** | **28** | | | |

## Fifth Semester (Effective for the students from the session 2013 – 14)

| S.No. | Course Category | Course No. | Course Title | Periods/week | | | Credit | Course Work Marks | Mid-Sem. Exam Marks | End Sem. Univ. Exam Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | | |
| 1 | DC | EL-311 | Digital Electronics | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 2 | DC | EL-312 | Active Network Synthesis | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 3 | DC | EL-342 | Digital Communication | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 4 | DC | EL-354 | Microwaves and Antennas | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 5 | DC | EL-332 | Microprocessors & Microcontrollers | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 6 | DC | EL-315 | VLSI Design & Technology | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 7 | DC | EL-395 | Electronics Lab - III | - | 1 | 2 | 2 | 60 | - | 40 |
| 8 | DC | EL-396 | Communication Lab - I | - | 1 | 2 | 2 | 60 | - | 40 |
| | | | **Total** | **18** | **8** | **4** | **28** | | | |

**Sixth Semester (Effective for the students from the session 2013 – 14)**

| S.No. | Course Category | Course No. | Course Title | Periods/week | | | Credit | Course Work Marks | Mid-Sem. Exam Marks | End Sem. Univ. Exam Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | | |
| 1 | OE | | Open Elective-I | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 2 | DE | | Departmental Elective-I | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 3 | HM | ME-340 | Economics & Management | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 4 | DC | EL-344 | Communication Networks | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 5 | DC | EL-343N | Digital Signal Processing | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 6 | DC | EL-380 | Colloquium | - | 2 | - | 2 | 100 | | |
| 7 | DC | EL-397 | Microprocessors Lab | - | 1 | 2 | 2 | 60 | - | 40 |
| 8 | DC | EL-398 | Communication Lab - II | - | 1 | 2 | 2 | 60 | - | 40 |
| | | | **Total** | **15** | **9** | **4** | **26** | | | |

**Seventh Semester (Effective for the students from the session 2014 – 15)**

| S.No. | Course Category | Course No. | Course Title | Periods/week | | | Credit | Course Work Marks | Mid-Sem. Exam Marks | End Sem. Univ. Exam Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | | |
| 1 | OE | | Open Elective – II | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 2 | DE | | Departmental Elective - II | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 3 | DE | | Departmental Elective - III | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 4 | ESA | CO-460 | Computer Architecture | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 5 | DC | EL-493 | Electronics Lab -IV | - | 1 | 2 | 2 | 60 | - | 40 |
| 6 | DC | EL-494 | Communication Lab - III | - | 1 | 2 | 2 | 60 | - | 40 |
| 6 | DC | EL-490A | Project | - | 2 | 4 | 4 | 60 | - | 40 |
| | | | **Total** | **12** | **8** | **8** | **24** | | | |

**Eighth Semester (Effective for the students from the session 2014 – 15)**

| S.No. | Course Category | Course No. | Course Title | Periods/week | | | Credit | Course Work Marks | Mid-Sem. Exam Marks | End Sem. Univ. Exam Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | | |
| 1 | OE | | Open Elective - III | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 2 | DE | | Departmental Elective - IV | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 3 | DE | | Departmental Elective - V | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 4 | DE | | Departmental Elective - VI | 3 | 1 | - | 4 | 15 | 25 | 60 |
| 5 | DC | EL-490B | (continued) Project | - | 2 | 4 | 4 | 60 | - | 40 |
| | | | **Total** | **12** | **6** | **4** | **20** | | | |

# LIST OF ELECTIVES

**Departmental Elective**

EL-314N Semiconductor Device Modelling

EL-412 Analog IC Design

EL-447 Multimedia Systems and Networks

EL-457 Mobile Communication

EL-456 Fiber Optic Communication

EL-410 RF System Design

EL-413 Digital IC Design

EL-415 Digital System Design

EL-458N TV and Radar Engineering

**Open Elective**

EL-320 Industrial Electronics & Instrumentation

EL432N Artificial Intelligence and Neural Network

# SYLLABI

| | | |
|---|---|---|
| **Course Number And Title** | **: EL-211N Electronic Devices** | |
| Credits | : 4 | |
| Course Category | : Departmental Core | |
| Pre-requisite(s) | : Basic Electrical & Electronics Engineering | |
| Contact Hours (L-T-P) | : 3-1-0 | |
| Type of Course | : Theory | |
| Course Assessment | : Course Work (Home Assignments & Quizzes) | (15%) |
| | Mid semester Examination (1 hour) | (25%) |
| | End semester Examination (3 hour) | (60%) |

## Course Objectives

To understand the basic operation of semiconductor devices and circuits

## Course Outcomes

After completing this course the students shall be able to:

1. Understand semiconductor devices through energy band diagrams
2. Analyse characteristics of semiconductor junctions
3. Differentiate between bipolar junction transistors and metal oxide semiconductor field effect transistors
4. Understand working principle of feedback amplifiers and oscillators

## Syllabus

***Unit-I Semiconductor physics and Diodes***

Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, and resistivity. Generation and recombination of carriers, PN junction: barrier potential, energy band diagram, diode equation, charge storage, recovery time, depletion and diffusion capacitances, Diode clipping and clamping circuits, Schottky diode; tunnel diode.

***Unit-II BJT***

BJT: minority carrier profile, current equation, base width modulation, transistor breakdown, temperature effects. BJT in different regions of operation, Ebers-Moll model, Biasing and bias stability, Small signal models for BJT, Analysis of single transistor amplifier: Inverting amplifier (CE), Voltage Buffer (CC), Current Buffer (CB), Frequency Response, High frequency analysis.

***Unit-III MOSFET***

MOSFET and its operation: Current equation, channel length modulation, oxide capacitance; Biasing and bias stability, Small signal models for MOSFET, Analysis of single transistor amplifiers: Inverting amplifier (CS), Voltage Buffer (CD), Current Buffer (CG), Frequency Response, High frequency analysis.

***Unit-IV Feedback amplifiers and oscillators***

Feedback concept, Negative feedback and its effects on amplifier characteristics, Positive feedback, principle of oscillator circuits, BJT and MOS oscillators.

**Text Book(s)/Reference Book(s)**


1. A. S. Sedra, K. C. Smith, *Microelectronic Circuits,* Oxford Univ Press, Sixth Edition: 2013.
2. J. Millman, C. Halkias and Chetan D. Parikh, *Integrated Electronics*, 2e, Tata MacGraw Hill, 2010.
3. Donald A. Neamen, *Semiconductor Physics and Devices* 3e, Tata MacGraw Hill, 2007.


**Relationship of COs with POs**

| **COs** | **POs** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i | j | k |
| 1 | X | | | | | | | | | | |
| 2 | X | X | | | X | | | | | | |
| 3 | X | | | | | | | | | | |
| 4 | X | X | | | | | | | | | |

| | | |
|---|---|---|
| **Course Number and Title** | : | **EL-212 Circuit Theory** |
| Credits | : | 4 |
| Course Category | : | Departmental Core |
| Pre-requisite(s) | : | Basic Knowledge of Mathematics |
| Contact Hours (L-T-P) | : | 3-1-0 |
| Type of Course | : | Theory |
| Course Assessment | : | Home Assignments (problems and Quizzes) (15%)<br>Mid semester Examination (1 hour) (25%)<br>End semester Examination (3 hours) (60%) |

## Course Objectives

To understand basics of analyzing ac & dc networks, fundamentals of graph theory. Familiarize the student with the concepts of two port networks and state variable analysis.

## Course Outcomes

After completing this course the student shall be able to:

1. Identify the main circuit elements and analyze simple circuits in time domain.
2. Apply network theorems, for solving DC circuits as well as AC circuits using frequency domain techniques.
3. Understand and apply the fundamentals of graph theory, mesh and nodal techniques for the analysis large circuits.
4. Analyse the network as a black box using the concepts of two port networks and calculate the relevant

## Syllabus

### *Unit-I Elementary Network Analysis*

Methods of Network analysis: Mesh and node variable analysis; Star Delta transformation; Steady state analysis of AC circuits, Characteristics of the sinusoid: Average , peak and effective values, Impedance concept, Active, reactive and complex power, Power factor, Q of coils and capacitors, Series and parallel resonances, Bandwidth and selectivity, Series Parallel reduction of AC/DC circuits, Superposition, Reciprocity, Thevenin's, Norton's, Millman's and Maximum power transfer theorems, Application of theorems to the analysis of AC and DC circuits, Steady state analysis with non-sinusoidal inputs.

### *Unit-II Graph Theory and Network Equations*

Introduction to graph theory, Network Matrices, Incidence and Reduced Incidence matrix, Loop Matrix, Fundamental loop matrix, Cut set and cut set matrix, Fundamental cut set matrix,

Relationship between network Matrices, Basic laws of circuit theory (KVL and KCL), Formulation of network equations, Fundamental loop equations and nodal admittance matrix, Tellegen's theorem and application.

***Unit-III Two Port Circuit Parameters***

Introduction to Two port networks, Two port network parameters: open circuit impedance Z parameters, short circuit admittance Y parameters, Hybrid h parameters, Chain parameters ABCD and g parameters, Image Impedances, T and pie network, Relationship between different two port network, Interconnection of two-port network: cascade, series, parallel, series-parallel and parallel-series connections, Indefinite admittance matrix and applications.

***Unit-IV Introduction to state variable analysis***

Introduction, basic consideration in writing state equations, order of complexity, Formulation of state equations, Solutions of state equations, State transition matrix.

**Text Book/References:**


1. M. E. Valkenburg, *Network Analysis* , PHI,1995
2. S. Ghosh, *Network Theory: Analysis and synthesis*, PHI,2005
3. Nagsarkar, *Circuits & Networks*, Oxford, 2010
4. Del Toro, *Principles of Electrical Engg*, PHI, 1994


**Relationship of COs with POs**

| **COs** | **POs** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i | j | k |
| 1 | X | X | | | | | | | | | |
| 2 | X | X | | | | | | | | | |
| 3 | | X | | | | | | | | | |
| 4 | | X | | | | | | | | | |
| 5 | X | | | | | | | | | | |

| | | | |
|---|---|---|---|
| **Course Number and Title** | **:** | **EL-213 Analog Electronics** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | Electronic Devices & Circuits | |
| Contact Hours (L-T-P) | : | 3-1-0 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Course Work (Home Assignments & Quizzes) | (15%) |
| | | Mid semester Examination (1 hour) | (25%) |
| | | End semester Examination (3 hour) | (60%) |

## Course Objectives

To understand the design of basic analog circuits using transistors and their applications in the design of ICs along with the applications of those ICs for analog signal processing.

## Course Outcomes

After successfully completion of this course, students shall be able to

1. Design and analyze transistor based analog circuits.
2. Design integrated circuits using basic transistor based circuits.
3. Use transistor models for performance analysis of circuits
4. Understand applications of analog ICs and exploring new ones for solving engineering problems.

## Syllabus

***Unit-I Differential amplifiers***

Differential pair, Small signal operation, Differential and Common mode gains, CMRR, Differential amplifier with active load, Frequency response of Differential amplifier, Biasing of ICs, cascode amplifier.

***Unit-II Operational Amplifier***

Design of operational amplifier: gain stage of opamp, level shifting stage of opamp., output stages: Class A, B, and AB, Gain and Frequency response of opamp.

***Unit-III Op-amp. Applications***

Non-ideal opamp parameters and their measurement, Current to Voltage and Voltage to Current Converters, Instrumentation amplifier, Precision Rectifiers, Log and exponential converters, Schmitt trigger and applications as monostable and astable multivibrators, Square /triangular wave generators, Voltage controlled oscillators.

***Unit IV Analog ICs Applications***

Astable and Monostable multivibrators using CMOS gates, 555 Timer circuit and applications, Analog Multiplier/ Divider using Log- antilog amplifier, Introduction to PLL.

**Text Book(s)/Reference Book(s)**


1. A. S. Sedra, K. C. Smith, *Microelectronic Circuits*, Oxford Univ Press, 2011.
2. S. Soclof, *Application of analog ICs*, PHI, 2004.
3. J. Millman, A. Grabel, *Microelectronics*, Mc Graw Hill, 1987.


**Relationship of COs with POs**

| **COs** | **POs** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i | j | k |
| 1 | X | X | | | | | | | | | |
| 2 | X | X | X | | | | | | | | |
| 3 | | X | | | X | | | | | | |
| 4 | | | X | | | | | | | | |

| | | | |
|---|---|---|---|
| **Course Number and Title** | : | **EL-222 Electronic Instrumentation** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | - | |
| Contact Hours (L-T-P) | : | 3-1-0 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Course Work (Home Assignments & Quizzes) | (15%) |
| | | Mid semester Examination (1 hour) | (25%) |
| | | End semester Examination (3 hour) | (60%) |

## Course Objectives

To familiarize the students with basic instruments like ammeter, voltmeter, wattmeters, CROs etc. Measurement of electrical parameters and an introduction to transducers.

## Course Outcomes

After completing this course the student shall be able to:

1. Classify measuring instruments.
2. Understand measurement techniques of power, power factor and frequency.
3. Understand measurement techniques of basic electrical components.
4. Acquire knowledge of construction details and applications of different types of CROs.
5. Explain different types of transducers and their applications.

## Syllabus

***Unit-I Standards, voltage and Current Measuring Analog Instruments***

Definitions of Accuracy, Precision, Resolution; Sensitivity and Linearity; Standards of Resistance and EMF; Classification of Measuring Instruments; Theory and Constructional Details of PMMC Instruments; Use of PMMC Instruments as Ammeter and Voltmeter; Moving Iron Instruments; Electronic Voltmeter and Its Special Features; Measurement of DC, RMS and Peak Values of AC Voltages by Electronic Voltmeter.

***Unit-Il Measurement of Power, Power Factor and Frequency***

Electrodynamometer Type Instruments: Theory and Constructional Details; Use of Electrodynamometer Type Instruments as Ammeter and Voltmeter; Theory and Constructional Details of Electrodynamometer Type, Induction Type and Hall Effect Type Wattmeters; Power factor Meters; Measurement of Frequency.

***Unit-III Measurement of Resistance, Inductance and Capacitance***

Techniques for The measurements of Low, Medium and High Resistances; Different Methods for The Measurement of Inductance and Capacitance; Theory of Q-Meters and Their Applications; Different Types of Ohmmeters and Their Applications

***Unit-IV Cathode Ray Oscilloscopes***

Important Components of a General Purpose CRO; Constructional Details of CRT; Theory and Design of Time Base Generator; Purpose of Synchronization; Introduction to Different Types of CROs: Dual Trace, Double Beam, Storage, Sampling and Digital Oscilloscopes; Applications 01 CRO's

***Unit-V Transducers***

Introduction; Different Types of Transducers; Measurement of Linear Displacement, Strain, Temperature, Pressure and fluid flow

**Text Book(s)/References Book(s)**

1. W.D. Cooper and A.D. Helfrick, *Electronic Instrumentation and Measurement Techniques*, Prentice Hall of India, 2005.

2. E.W. Golding and F.C. Widdis, *Electrical Measurements and Measuring Instruments*, Wheeler Publishing, 1993.

**Relationship with POs**

| **COs** | **POs** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i | j | k |
| 1 | x | | | | | | | | | | |
| 2 | x | x | | | | | | | | | |
| 3 | x | x | x | x | | | | | | | |
| 4 | x | | x | | | | | | | | |
| 5 | x | | x | x | | | | | | x | |

| | | | |
|---|---|---|---|
| **Course Number and Title** | : | **EL-223 Control Systems** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | Signals and Systems | |
| Contact Hours (L-T-P) | : | 3-1-0 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Course Work (Home Assignments & Quizzes) | (15%) |
| | | Mid semester Examination (1 hour) | (25%) |
| | | End semester Examination (3 hour) | (60%) |

## Course Objectives

To familiarize the students with basic concept of control systems. To study the concepts and techniques of stability for linear and non-linear control systems.

## Course Outcomes

After successfully completion of this course, students shall be able to

1. To understand the basic concept of control systems.
2. To test the stability for linear and non-linear systems.
3. Design of linear control systems.
4. Application of the most powerful technique of state-space.

## Syllabus

***Unit-I Classification and Components of Control Systems***

Introduction to Control Systems; Classification of Control Systems: Open-loop and Closed-loop, Linear and Nonlinear, Continuous and Discrete-time, Deterministic and Stochastic, SISO and MIMO, Static and Dynamic, Causal and Non-causal, Time Varying and Time Invariant, Forced and Forced-free, Autonomous and Non-autonomous; Control System Components: Potentiometer, Synchro, Tachometer, Gyroscope, DC Servomotors, AC Servomotor and Their Modelling; DC and AC Servo systems.

***Unit-II Stability of Linear Control Systems***

Introduction, BIBO Stability, Methods of Determining Stability: Routh-Hurwitz Criterion, Bode's Plot, Gain and Phase Margins, Root-locus, Nyquist Stability Criterion

***Unit-III Compensation Techniques***

Concepts of Compensation; Steady State Errors; Design of Phase Lead and Phase Lag Compensators; Effects of Compensation on the Systems Performance; Industrial Controllers: P, PI, PD and PID Controllers

***Unit-IV State Variable Analysis***

Introduction; Representation of State Equations; Relationship Between State Equations and Differential Equations and Transfer Functions; Solution of State Equations; State Transition Matrix; State Transition Equation; Different Forms of State Equations; Controllability and Observability of Control Systems.

***Unit-V Analysis of Nonlinear Control Systems***

Introduction to Nonlinear Systems; Physical Nonlinearities; Equivalent Linearization; Describing Function Technique; Stability Analysis Using Describing Function.

**Text Book(s)/Reference Book(s)**


1. I. J. Nagrath and M. Gopal, *Control System Engineering*, New Age Int., 2007.
2. B.C. Kuo, *Automatic Control Systems*, Prentice Hall of India, 2004.
3. K. Ogatta, *Modern Control Engineering*, Prentice Hall of India, 2002.
4. Rihan M., *Advanced Control System*, Axioe Publication, 2011


**Relationship of COs with POs**

| **COs** | **POs** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i | j | k |
| 1 | X | | | | | | | | | | |
| 2 | X | X | | | | | | | | | |
| 3 | X | | X | | | | | | | | |
| 4 | X | X | | | | | X | | | | |

| | | | |
|---|---|---|---|
| **Course Number and Title** | : | **EL-231 Logic Circuits** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | -- | |
| Contact Hours (L-T-P) | : | 3-1-0 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Course Work (Home Assignments & Quizzes) | (15%) |
| | | Mid semester Examination (1 hour) | (25%) |
| | | End semester Examination (3 hour) | (60%) |

## Course Objectives

To understand the mathematical basis for analysis and design of modern digital systems. To learn the axioms and important theorems of Boolean algebra. To elaborate the fundamentals of Combinational and Sequential logic. To study the analysis and design of basic building blocks of digital systems. To apply logic circuits for designing common arithmetic circuits.

## Course Outcomes

After completing this course the students should be able to:

1. Describe the Boolean algebraic structure used for logic and digital circuits.
2. Carry out mathematical operations in binary number system and learn different binary codes.
3. Analyse combinational and sequential logic circuits.
4. Design combinational and sequential logic circuits.
5. Apply logic circuits for basic arithmetic operations like addition, subtraction etc.

## Syllabus

***Unit-I Boolean Logic***

Boolean algebra - Huntington's postulates, basic theorems, universal sets; Switching algebra; Logic function representation – Canonical SOP and POS forms, Truth Tables, Minterm and maxterm list ; Logic Gates; Introduction to Number systems – Binary, Octal, Hexadecimal and inter-conversion; One's and two's Complement – signed representation, addition and subtraction, Binary codes – BCD, Gray, Alphanumeric codes.

***Unit-II Combinational Logic Design***

Logic function minimization **–** Karnaugh map, Prime implicants, SOP and POS forms, Don't care conditions; Encoder, Decoder/Demultiplexer, Multiplexer; VEM, Function

implementation with Multiplexer and Decoder; Magnitude Comparator; Priority Encoder; Code converters; Introduction to Programmable logic devices.

***Unit-III Sequential Logic Design***

Definition and State Representation, Mealy and Moore machines, Latch and Flip-Flop - RS, JK, D, T Flip-Flops and their Operation, State Tables, Excitation Tables and Triggering; Registers, Universal Shift Register; Synchronous design; Asynchronous and Synchronous Counters - Design and Analysis, Ripple, Up/Down, Modulo-n, Johnson, Ring Counters; Ring oscillator.

***Unit-IV Selected Topics***

Arithmetic Functions–Half Adder, Full Adder, Binary Adder/Subtractor; Look Ahead Carry Generator, Decimal Adder;BCD-to-7-Segment Decoder/Driver; Implementation using XOR and XNOR gates -Parity Checker/Generator, BCD-Gray Code converter; Tabular method for Logic function minimization.

**Text Book(s)/Reference Book(s)**


1. M. M. Mano and M. D. Ciletti, *Digital Design*, 4th ed**.**, Pearson Education, 2007.
2. R. J. Tocci, N. S. Widmer and G. L. Moss, *Digital Systems: Principles and Applications*, 9th ed., Pearson Education, 2004.
3. C. H. Roth, Jr. *Fundamentals of Logic Design*, 5th ed. 2004, Cengage Learning.
4. N. Balabanian and B. Carlson, *Digital Logic Design Principles*, 2001, Wiley.


**Relationship of COs with POs**

| **COs** | **POs** | | | | | | | | | | |
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|---|---|---|
| **Course Number and Title** | : | **EL-241 Signals and Systems** |
| Credits | : | 4 |
| Course Category | : | Departmental Core |
| Pre-requisite(s) | : | Higher Mathematics - I |
| Contact Hours (L-T-P) | : | 3-1-0 |
| Type of Course | : | Theory |
| Course Assessment | : | Home Assignments (including MATLAB based Problems and Quizzes (15%)<br>Mid semester Examination (1 hour) (25%)<br>End semester Examination (3 hours) (60%) |

## Course Objectives

To understand basics of signals and systems, classifications of signals and systems; time and frequency domain analysis of signals and systems using various transforms.

## Course Outcomes

After completing this course the student shall be able to:

1. Describe and characterize various properties of signals and systems.
2. Compute Fourier series, Fourier transform, Laplace transform and Z-transform of signals.
3. Use Nyquist sampling theorem to choose adequate sampling rate.
4. Apply block diagram reduction technique and Mason's gain formula to determine transfer function of complex systems.
5. Understand random signals and random process.

## Syllabus

***Unit-I Introduction to Signals and Systems***

Definition and examples of signals and Systems; Mathematical modeling; Classification of Signals and Systems; Singularity functions; Representation of signals using basis functions; Exponential Fourier series and its application in signal theory; Concept of Frequency spectra; Convolution integral and its applications; Concept of system impulse response and its properties

***Unit-II Transform Techniques***

Frequency domain representation of continuous time signals; Fourier transform and its properties; Hilbert Transform; Bandpass signals and their mathematical description; Laplace transform and its relationship with Fourier transform; Overview of sampling; Z-transform and its properties; Inverse z-transform; Discrete-time Fourier transform; Discrete Fourier Transform

***Unit-III Analysis using Transforms***

System representation using transfer function; Feedback and stability of system; Block diagram reduction techniques; Signal flow graph and Mason's gain formula; Time and frequency response of I and II order systems; Discrete-time system representations; Analysis of discrete-time systems.

***Unit-IV Random Signals***

Review of random variables; Probability distribution and probability density functions; Classification of random variables (according to their distribution); Statistical Averages; Functions of random variables; Introduction to random process; Stationarity, mean, correlation and covariance function; Ergodicity and central limit theorem; Power spectral density; Gaussian random process and its properties; Analysis of LTI systems with random inputs; Noise and its representation

## Text Book(s)


1. A. V. Oppenheim and A. S. Willisky, *Signals and Systems*, 2nd Edition, Prentice Hall India, 2010.
2. B. P. Lathi, *Linear systems and Signals*, Oxford University Press, India, 2010.


## Reference Book(s)


1. B. P. Lathi, *Signal Processing and Linear Systems*, Oxford Univ. Press, 2000.
2. M. Mandal and Amir Asif, *Continuous and Discrete Time Signals and Systems*, Cambridge Univ. Press, 2007.
3. S. Haykin, *Communication Systems*, 4th Edition, John Wiley, 2001.
4. G. R. Cooper and C D McGillen, *Probabilistic methods of signals and system analysis*, Oxford Univ. Press, 1998.


## Relationship of COs with POs

| **COs** | **POs** | | | | | | | | | | |
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|---|---|---|
| **Course Number and Title** | : | **EL-242 Principles of Communication Engineering** |
| Credits | : | 4 |
| Course Category | : | Departmental Core |
| Pre-requisite(s) | : | Signals and Systems |
| Contact Hours (L-T-P) | : | 3-1-0 |
| Type of Course | : | Theory |
| Course Assessment | : | Home Assignments (including MATLAB based problems and Quizzes) (3-4 assignments) (15%)<br>Mid semester Examination (1 hour) (25%)<br>End semester Examination (3 hours) (60%) |

## Course Objectives

To understand the analog modulation/demodulation techniques and to apply them in practical communication systems.

## Course Outcomes

After completing this course the students shall be able to:

1. Understand and comprehend the issues related to continuous and pulse modulation/demodulation
2. Design analog modulation/demodulation systems
3. Understand baseband communication issues
4. Analyse the effect of noise on the performance of communication system

## Syllabus

***Unit I Continuous Wave (CW) Modulation***

Representation of band-pass signals, Need of Modulation, Frequency translation, Amplitude modulation systems (AM, DSBSC, SSBSC, VSB modulation/demodulations); Angle modulation: Generation and Demodulation of FM; Non-linear effects in AM and FM systems; Frequency Division Multiplexing; Superhetrodyne Radio Receiver.

***Unit II Pulse Modulation***

Sampling Theorem, Various sampling Techniques, Sampling of Low Pass and Bandpass Signals, Time Division Multiplexing, Generation and Recovery of PAM, PWM and PPM, Introduction to PCM, Quantization, Quantization Errror, Line Coding, Companding, Differential PCM (DPCM), Delta Modulation, Slope Overloading and Granular Noises, Adaptive DPCM and Adaptive Delta Modulation, Digital Multiplexing (T1 and E1 Systems).

***Unit III Noise in Modulation Systems***

Different types of noise, Equivalent Receiver model, Noise in CW Receivers using Coherent Detection, Noise in CW Receivers using Envelope Detector, Noise in FM Receivers, Threshold Effect, Noise in PCM System: transmission and quantization noise.

***Unit IV Baseband Pulse Transmission***

Introduction, Matched Filter and Correlation Receivers, Error rate due to Noise, Inter-symbol Interference (ISI) and Eye Patterns; Nyquist criterion of distortion-less baseband transmission, Baseband Pulse Shaping, Correlative Coding, Equalization Techniques.

**Text Book(s)**


3. Simon Haykin, *Communication Systems*, 4th Edition, John Wiley & Sons, 2001.
4. B. P. Lathi, *Modem Digital and Analog Communication Systems*, 3rd Ed., Oxford Press, 2004.


**Reference Book(s)**


1. H. Taub, D. L. Schilling & G. Saha, *Principles of Communication Systems*, 3rd Edition, Tata McGraw Hill, 2008.
2. A. B. Carlson, "Communication Systems", McGraw Hills, 2002.
3. R. E. Ziemer & W. H. Tranta, "Principles of Communications", 5th Edition, John Wiley, 2002.
4. J. G. Proakis & M. Salehi, "Communication Systems Engineering", 2nd Edition, Pearson Education, 2006.
5. R. P. Sigh and S. D. Sapre, "Communication Systems: Analog and Digital", 2nd Edition, TMH, 2007.


**Relationship of COs with POs**

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| **Course Number and Title** | : | **EL296 Electronics Lab-I** | |
| Credits | : | **2** | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | Basic Electrical & Electronics | |
| Contact Hours (L-T-P) | : | 0-1-2 | |
| Type of Course | : | Laboratory | |
| Course Assessment | : | Lab reports | (35%) |
| | | Practical Test and Viva (1 hour) | (25%) |
| | | End semester Examination (2 hour) | (40%) |

## Course Objectives

Understanding of the function and operation of the various electronic equipment/ instruments i.e. Cathode Ray Oscilloscope, Digital storage Oscilloscope, Function Generators, Power supply, Voltmeters, Ammeters etc. Able to perform various experiments using the electronic equipment/ instruments.

## Course Outcomes

After successfully completion of this course, students will be able to

1. Operate equipment and instruments of the laboratory.
2. Perform various basic experiments.
3. Analyze and interpret the results of experimentation.
4. Prepare an effective lab report and give viva-voce.

## List of Experiments

1. Plot the characteristics of ordinary semiconductor diode and Zener diode.
2. Design and test RC phase shift circuit for a given frequency and phase shift.
3. Design Integrator and differentiator circuit for a given frequency and test it for sine and square waveforms.
4. Design and test inverting and non-inverting amplifier for given gain.
5. Trace and measure from CRO input and output waveforms of full wave rectifier with and without filter.
6. Plot the characteristic of a given BJT.
7. Design and test Wein's bridge oscillator circuit for given frequency.

## References


1. Sedra Smith, *Microelectronic Circuits*, Oxford University Press, 2005.
2. Theodore F. Bogart Jr., *Electronic Devices and Circuits*, UBS Publishers, 1998.

3. A. S. Khan, A Guide to *Laboratory Practice,* Electronics Engineering Department, A. M. U. Aligarh

**Relationship of COs with POs**

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|---|---|---|---|
| **Course Number and Title** | : | **EL-297 Electronics Lab-II** | |
| Credits | : | 2 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | Logic Circuits | |
| Contact Hours (L-T-P) | : | 0-1-2 | |
| Type of Course | : | Practical | |
| Course Assessment | : | Course Work in laboratory | (40%) |
| | | Laboratory assessment | (20%) |
| | | End semester Examination (2 hours) | (40%) |

**Course Objectives**

Learning the operation of various electronic equipment. Ability to perform experiments for verifying the operation of digital circuits.

**Course Outcomes**

After completion of this course, students will be able to

1. Verify the functioning of logic gates and basic digital ICs.
2. Design and perform various experiments on operation of logic circuits.
3. Analyze and interpret the results of experimentation.
4. Prepare an effective lab report and give viva-voce.

**Experiments:**

1. To verify the truth-tables of basic logic gates.
2. To design and implement the circuit of Mod-8 Asynchronous and Mod-6 Synchronous counter using J-K flip-flops.
3. Study and verification of load, shift and rotate operation on 4-bit Shift register.
4. Design and test a 4-bit R-2R ladder type DAC.
5. Implement and verify 4line to 2-line Priority Encoder.
6. Design and test a Gray to BCD code converter and show the output on 7-segment display.
7. To test a 4-bit programmable Adder/Subtractor.
8. To test an 8-line to 1-line MUX and using it implement a given 4-variable function.
9. Obtain the transfer characteristics of CMOS inverter.
10. To verify the truth-table of CMOS NOT, NAND and NOR gate.

## Text Book(s) / Reference Book(s)


1. M. M. Mano and M. D. Ciletti, *Digital Design*, 4th ed. 2007, Pearson.
2. R. J. Tocci, N. S. Widmer and G. L. Moss, *Digital Systems: Principles and Applications*,9th ed. 2004, Pearson.


## Relationship of COs with POs:

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| **Course Number and Title** | : | **EL-298 Instrumentation Laboratory** | |
| Credits | : | 2 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | Electronic Instrumentation | |
| Contact Hours (L-T-P) | : | 0-1-2 | |
| Type of Course | : | Practical | |
| Course Assessment | : | Course Work in laboratory | (40 %) |
| | | Laboratory assessment | (20 %) |
| | | End semester Examination (2 hours) | (40%) |

**Course Objectives**

To familiarize the students with basic instruments like ammeter, voltmeter, wattmeters, CROs and the measurements involving transducers and basic electronic devices.

**Course Outcomes**

After completing this course the students shall be able to:

1. Measure different electrical quantities.
2. Perform calibration of various instruments.
3. Analyze and interpret the results of experimentation.
4. Prepare an effective lab report and give viva-voce.

**Experiments:**

1. (a) Plot the dynamic volt-amp characteristics of the given SC diode and hence, determine its forward resistance.
   (b)Plot the dynamic volt-amp characteristics of the given Zener diode and hence determine its breakdown voltage.
2. Design and test the Schmitt trigger circuit.
3. Measure the given frequency and frequency deviation using Wein's bridge.
4. Calibrate the pressure measuring system.
5. Calibrate the given strain gauge.
6. Calibrate the given thermistor.
7. To determine the value of a capacitor using an RC phase shift oscillator.
8. To draw the characteristics of the LVDT for ac and dc output.
9. To calibrate the given wattmeter with the help of dc potentiometer using Phantom method of loading.

10. To measure frequency and frequency deviation with the help of frequency sensitive active bridge.

**Text Book(s)/Reference Book(s)**


1. W.D. Cooper and A.D. Helfrick, *Electronic Instrumentation and Measurement Techniques*, Prentice Hall of India, 2005.
2. E.W. Golding and F.C. Widdis, *Electrical Measurements and Measuring Instruments*, Wheeler Publishing, 1993.


**Relationship of COs with POs**

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|---|---|---|---|
| **Course Number and Title** | : | **EL-311 Digital Electronics** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | **:** | Logic Circuits, Electronic Devices & Circuits | |
| Contact Hours (L-T-P) | : | 3-1-0 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Course Work (Home Assignments & Quizzes) | (15%) |
| | | Mid semester Examination (1 hour) | (25%) |
| | | End semester Examination (3 hour) | (60%) |

## Course Objectives

To understand the concepts and terminology of digital electronics. Familiarize students with transistor level designing of logic gates, memories and data converters.

## Course Outcomes

After completing this course the student shall be able to:

1. Understand and compare different logic families.
2. Differentiate and Design different types of digital and logic circuits using BJTs and MOSFETs.
3. Design different types of memories (ROM, EEPROM, RAM etc.) using MOS logic.
4. Understand the applications of ROM in practical scenario.
5. Understand different ADCs and DACs and use them in practical applications.

## Syllabus

***Unit-I Logic Families***

Digital IC Terminology; TTL Logic Family; Analysis of TTL Gates; NAND, NOR, AOI Gates; Schottky TTL; Open Collector and Tri-State TTL; Emitter Coupled Logic; Basic ECL Circuits; ECL OR/NOR Gate.

***Unit-II MOS Based Circuits***

MOS and CMOS Logic Circuits and Characteristics; CMOS Inverter, NAND, NOR, X-OR, X-NOR Gates; CMOS Complex Gates; CMOS Transmission Gate; CMOS Clocked S-R and D- Flip-Flops. Pseudo NMOS Logic Circuits; Pseudo NMOS Inverter and other Gates; Pass Transistor Logic (PTL) and Complementary Pass Transistor Logic (CPTL); Realization of Different Gates in PTL and CPTL; Bi-CMOS Digital Circuits; Introduction to Bi-CMOS; Comparison of various Logic Families.

***Unit-III Memory Devices***

Memory Terminology, Semiconductor Memories; Types and Architecture; ROM-Architecture, Addressing and Timing; MOS ROM; PROM, EPROM, EEPROM (EAPROM), ROM Applications; Programmable Logic Device Arrays (PAL and PLA); ROM/PLD Based Combinational Design; Semiconductor RAM -- RAM Organization; Static RAM, Dynamic RAM; DRAM Structure and Operation; Read/Write Cycles; DRAM Refreshing; Expanding Word Size and Capacity; Concepts of CCD.

***Unit-IV: Data Converters***

Principle of Operation of Digital-to-Analog Converters (DACs); Basic Circuits Using Binary Weighted Resistors and R/2R Ladder; DAC Specification; DAC Applications, Analog-to Digital Converters (ADCs); -Digital Ramp ADC, Up/Down Digital Ramp ADC, (Tracking ADC), Successive Approximation ADC; Flash ADC, Dual Slope Integrated ADC; Data Acquisition, Sample and Hold Circuits; Multiplexed ADC.

**Text Book(s)/Reference Book(s)**


1. Ronald. J. Tocci, And Neal .S. Widmer, *Digital Systems - Principles And Applications*, Eighth Edition, Pearson Education, New Delhi, 2001
2. A.S. Sedra and K.C. Smith, *Microelectronic Circuits*, Oxford University Press, 5th Edition, 2004.
3. J. Millman and Grabel, *Microelectronics*, McGaw Hill, 1987.


**Relationship of COs with POs**

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| **Course Number and Title** | **:** | **EL-314N Semiconductor Device Modelling** |
| Credits | : | 4 |
| Course Category | : | Departmental Elective |
| Pre-requisite(s) | : | Electronic Devices & Circuits |
| Contact Hours (L-T-P) | : | 3-1-0 |
| Type of Course | : | Theory |
| Course Assessment | : | Course Work (Home Assignments & Viva) (15%) |
| | | Mid semester Examination (1 hour) (25%) |
| | | End semester Examination (3 hour) (60%) |

## Course Objectives

To provide a solid understanding of physical principals of basic semiconductor devices and their models.

## Course Outcomes

At the end of this course you should be able to

1. Understand electronics properties and physics of charged transport in semiconductors.
2. Analyse semiconductor junctions through energy-band diagrams.
3. Use models of semiconductor devices to predict terminal characteristics under various operating conditions.
4. Understand second order effects in BJT and MOSFETs.

## Syllabus

***Unit-1 Basic Semiconductor Physics***

Quantum Mechanical Concepts and Atomic States; Solid State Structure; Band Structure; Semiconductor Statistics; Intrinsic, Extrinsic & Compensated Semiconductors; Electron and Hole Mobilities and Drift Velocities; Hall Effect and Magnetoresistance; Semiconductor Equations Based on the Field Dependent Velocity and Diffusion; Quasi-Fermilevels; Generation and Recombination of Carriers.

***Unit-II Models for p-n Junction, Schottky Barrier Junction, Hetero Junction and Ohmic Contacts***

P-N Junction Under Zero Bias; I-V Characteristics Of p-n Junction; Generation & Recombination Currents; Depletion & Diff. Capacitances; Junction Breakdown; Tunneling and Tunnel Diodes; Schottky Barrier: Thermionic Emission Model, V-I Characteristics and Thermionic-Field Emission Models; Ohmic Contacts and Heterojunctions.

***Unit-III Bipolar Junction Transistors***

Minority Carrier Profiles; Current Components; Base Spreading Resistance; Emitter Current Crowding; Graded Base Transistors; Early Effect; Ebers-Moll Model; Gummel-Poon Model; Breakdown; Small signal model and high frequency models.

***Unit-IV Field Effect Transistors***

MOS Capacitor; C-V Characteristics; MOSFET: Gradual Channel Approximation and Charge Control Model; Charge Sheet Model; Constant Mobility Model; Velocity Saturation Effects; Sub-Threshold Current in MOSFETs; Large Signal Modeling; Small Signal Modeling (Low & Medium Frequency); High Frequency Small Signal Models; MOSFET Modeling for Circuit Simulation.

**Text Book(s)/Reference Book(s)**


1. M. Shur, *Physics of Semiconductor Devices,* Prentice Hall of India, 1990.
2. Neamen, *Semiconductor Physics and Devices* Tata McGraw Hill, 2011
3. Y. Tsividis, *Operation and Modeling of the MOS,* McGraw Hill, 1999.


**Relationship of COs with POs**

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| **Course Number and Title** | **:** | **EL-315 VLSI Design and Technology** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | Logic Circuits | |
| Contact Hours (L-T-P) | : | 3-1-0 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Course Work (Home Assignments & Quizzes) | (15%) |
| | | Mid semester Examination (1 hour) | (25%) |
| | | End semester Examination (3 hour) | (60%) |

## Course Objectives

To gain an understanding of the VLSI Design & Technology and their applications in the design of Analog and Digital Circuits and Systems.

## Course Outcomes

At the end of the course student shall be able to:

1. Outline the concept of VLSI Design and Technology.
2. Describe basic digital circuits using HDL.
3. Design CMOS based analog and digital circuits.
4. Understand IC processing steps along with the introduction to hybrid BJT and CMOS technology

## Syllabus

***Unit-I VLSI System Design***

VLSI Design Problem; Design Flow of VLSI Systems; Introduction to High level Design (HDL Based Design); RTL Based Description of Digital Systems; Concept of Critical Path in Synchronous Systems; Concept of Data path and Control Path; Design of Uniprocessor; Pipelined and Parallel Architectures for a Given Algorithm.

***Unit II VLSI Circuit Design***

High Frequency MOS Models; Design and Performance Optimization of Static CMOS Gates Using Logical Effort; Design Flow of Analog Circuits; Design of CMOS Inverting Amplifier; Design Parameter Optimization in Analog Design (Gain, Bandwidth, Input/Output Impedance, Output Swing, Slew Rate, Noise, Linearity, Offsets, Power); Integrated Circuit Layout and Design Rules; Layout of a CMOS Inverter, NAND and NOR Gates

***Unit III IC Processing Steps***

Mask Making and Pattern Generation; Mask and Printing Defects; Yield; Basic Processing Steps of IC Fabrication; Lithography; Wet and Dry Etching; Oxidation, Diffusion, Ion Implantation; Annealing, Epitaxial Growth, CVD, Metallization.

***Unit IV IC Process Integration***

Self Alignment; Isolations: Junction Isolation; Guard-Ring; Shallow and Deep Trench; Local Oxidation; CMOS Technology: High-k Processes, Bipolar Technology, BiCMOS Technology; Introduction to SOI and GaAs.

## Text Book(s)/Reference Book(s)


1. Jan M. Rabaey, Anantha P. Chandrakasan, Borivoje Nikolić, *Digital Integrated Circuits*, 2/e, Pearson Education, 2003.
2. Behzad Razavi, *Design of Analog CMOS Integrated Circuits*, McGraw Hill, 2002.
3. S.A. Campbell, *The Science and Engineering of Microelectronic Fabrication*, Oxford University Press, 2001.
4. J. D. Plummer, M. Deal & P.D. Griffin, *Silicon VLSI Technology: Fundamentals, Practice, and Modeling*, Prentice Hall, 2000.


**Relationship of COs with POs**

| **COs** | **POs** | | | | | | | | | | |
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| **Course Number and Title** | **:** | **EL-332 Microprocessors & Microcontrollers** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | Logic Circuits | |
| Contact Hours (L-T-P) | : | 3-1-0 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Course Work (Home Assignments & Viva) | (15%) |
| | | Mid semester Examination (1 hour) | (25%) |
| | | End semester Examination (3 hour) | (60%) |

## Course Objectives

Understanding of the fundamental concepts of microprocessor, microcontroller and their architecture. Familiarization of interfacing techniques between microprocessor and its peripherals.

## Course Outcomes

After completing this course the students should be able to:

1. Understand hardware aspects of the microcomputer as a system.
2. Understand instruction set of 8085 microprocessor.
3. Understand various types of data transfer between microprocessor and its peripherals.
4. Design interfacing circuits for microprocessor applications.
5. Understand the functions and programming of several programmable devices.

## Syllabus

***Unit-I The 8085 Microprocessor***

Introduction to microcomputer architecture, 8085 microprocessor architecture, Instruction set of 8085, assembly language programming, timing and control unit, Instruction cycle, Comparison of different machine cycles.

***Unit-II Data Transfer Schemes***

Hardware schemes for data transfer - Programmed data transfer, Interrupt data transfer and DMA, Interrupt structure of 8085, enabling, disabling and masking of interrupts, Various interrupt schemes, Multiple interrupts, Programmable Interrupt Controller (8259), DMA and DMA Controller (8257).

***Unit-III Interfacing Memory and I/O Devices***

Need of interfacing; Address space partitioning – Memory mapped I/O and I/O Mapped I/O, Advantages and Disadvantages; 8085 Minimal System; Interfacing Devices - 8255 (PIC), 8251 (USART), 8253 (Timer), 8279 (Keyboard Controller).

***Unit-IV Microcontrollers and Advanced Microprocessor***

Architecture of 8051 Microcontroller, signals, I/O ports, memory, counters and timers, serial data I/O, interrupts, interfacing with DAC/ADC, Introduction to 8086 microprocessor.

**Text Book(s)/Reference Book(s)**


1. R. S. Gaonkar, *Microprocessor Architecture, Programming and Applications*, Wiley Eastern Limited 5th edition.
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay *The 8051 Microcontroller and Embedded Systems*, Second Edition, Pearson Education, 2008.
3. Douglas V. Hall, *Microprocessor and Interfacing – Programming and Hardware*, Tata McGraw Hill, 2006.
4. M. Rafiquzzaman, *Microprocessor and Microcomputer Development System*, Cambridge Publications, Harper and Row, 1997.
5. A. P. Malvino, *Digital Computer Electronics- An Introduction to Microcomputer*, Tata McGraw Hill 2nd edition.


**Web Resources**

1. https://www.coursera.org/
2. http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-263j-data-communication-networks-fall-2002/
3. http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-829-computer-networks-fall-2002/
4. http://nptel.iitm.ac.in/courses/IIT-MADRAS/Computer_Networks/index.php

**Relationship of COs with POs**

| COs | POs | | | | | | | | | | |
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|---|---|---|---|
| **Course Number and Title** | : | **EL-342 Digital Communication** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | Principles of Communication Engineering | |
| Contact Hours (L-T-P) | : | 3-1-0 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Course Work (Home Assignments & Quizzes) | (15%) |
| | | Mid semester Examination (1 hour) | (25%) |
| | | End semester Examination (3 hour) | (60%) |

## Course Objectives

This course is devoted to the study of principles of digital communications. The emphasis is on the fundamentals that are essential to understand and design modern digital communication systems.

## Course Outcomes

After completing this course the students should be able to:

1. Design detectors for digital communication systems
2. Understand various digital modulation techniques
3. Analyze the error performance of digital modulation techniques
4. Know basic concepts of information theory and coding
5. Understand basics of spread spectrum communication

## Syllabus

***Unit-I Signal Space Analysis and Detection***

Geometric Representation of Signals; Gram Schmidt Orthogonalization Procedure; Detection of Known Signals in Noise; MAP and ML Criteria; Probability of Error; Correlation and Matched Filter Receivers.

***Unit-II Passband Communication***

Introduction; Digital Modulations: ASK, PSK, FSK, QPSK, QAM and MSK; Power Spectra of Baseband and Passband Signals; Coherent and Noncoherent Detection of Modulated Signals; Probability of Error in Detection; Comparison of Various Modulation Techniques.

***Unit-III Information Theory and Coding***

Introduction; Discrete Memoryless Sources; Information Measure; Source Coding Theorem and Source Coding Techniques; Channel Capacity; Channel Coding and Channel Capacity

Theorems; Error Detection and Correction; ARQ Protocols; Linear Block Codes; Convolutional Codes.

***Unit-IV Spread Spectrum Communication***

Introduction; Spreading Sequences; Direct Sequence Spread Spectrum; Frequency and Time Hopping Spread Spectrum; Applications of Spread Spectrum.

## Text Books


1. J G Proakis and M Salehi, *Digital Communications*, 5th Edition, McGraw Hill Education (India) Private Limited, 2014.
2. S Haykin, *Digital Communication*, John Wiley & Sons, 2000.


## Other References


1. B P Lathi and Z Ding, *Modern Digital and Analog Communication Systems*, 4th Edition, Oxford Univ. Press, 2010.
2. B Sklar, *Digital Communication: Fundamentals and Applications*, 2nd Edition, Pearson Education Asia, 2002.
3. Tri T Ha, *Theory and Design of Digital Communication*, Cambridge Univ. Press, 2010.
4. R Bose, *Information Theory, Coding and Cryptography*, 2nd Edition, Tata McGraw Hill, 2008.
5. G R Cooper and C D McGillem, *Modern Communication and Spread Spectrum*, McGraw Hill, 2006.
6. H P Hsu, Schaum's Outlines: Analog and Digital Communications, 3rd Edition, McGraw Hill Education (India) Private Limited, 2009. [**For practice problems**]


## Relationship of COs with POs

| **COs** | **POs** | | | | | | | | | | |
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|---|---|
| **Course Number and Title** | : **EL-343N Digital Signal Processing** |
| Credits | : 4 |
| Course Category | : Departmental Core |
| Pre-requisite(s) | : Signals and Systems |
| Contact Hours (L-T-P) | : 3-1-0 |
| Type of Course | : Theory |
| Course Assessment | : Course Work (Home Assignments & Quizzes) (15%)<br>Mid semester Examination (1 hour) (25%)<br>End semester Examination (3 hour) (60%) |

## Course Objectives

To gain an understanding of the fundamental concepts in digital signal processing and familiarize the student with FFT computation, filter design problems and basic multirate systems.

## Course Outcomes

After completing this course the students should be able to:

1. Describe and analyse discrete time signals and systems in the time and frequency domain.
2. Design and simulate digital filters;
3. Solve digital signal processing problems using MATLAB.
4. Analyse the errors in hardware realization of discrete time systems.

## Syllabus

***Unit-I Discrete Fourier Transform (DFT)***

Review of DFT, Functional Operations with DFT; Efficient Computation of DFT; FFT Algorithm; Fourier Analysis of Signals using DFT.

***Unit-II Infinite Impulse Response (IIR) Filters***

Frequency response for Rational System Functions; All pass and Minimum Phase Systems; Basic Structure for IIR Filters; Design of IIR Filters from Continuous Time Filters; Frequency Transformations of IIR Low Pass Filters; Computer Aided Design of IIR Filters.

***Unit-III Finite Impulse Response (FIR) Filters***

Linear Systems with Generalized Linear Phase; Basic Network Structures for FIR Filters; Design of FIR Filters; Window Function Methods and Frequency Sampling Technique; Comparison of FIR and IIR Filters.

***Unit-IV Finite Word Length Effects in DSP***

Overview of Finite Precision Numerical Effects; Effects of Round Off Noise in Digital Filters; Effect of Finite Register Length in DFT Computation; Introduction to Multirate Digital Signal Processing

**Text Book(s)/Reference Book(s)**


1. A.V. Oppenheim & R. W. Schafer, *Discrete Time Signal Processing*, PHI, 1992.
2. J.G. Proakis & D.G. Manolakis, *Digital Signal Processing Principles, Algorithms and Applications*, PHI 2006.
3. A. Antoniou, *Digital Filters: Analysis, Design and Applications*, Tata McGraw Hill Book Co., 2006.
4. S.K. Mitra, Digital Signal Processing: A Computer-Based Approach, 4/e, Tata McGraw Hill Education, 2011


**Web Resources**

1. https://www.coursera.org/course/dsp
2. http://nptel.ac.in/video.php?subjectId=117102060
3. http://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/
4. http://utubersity.com/?page_id=906

**Relationship of COs with POs**

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| **Course Number and Title** | : | **EL-344 Communication Networks** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | Digital Communication | |
| Contact Hours (L-T-P) | : | 3-1-0 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Course Work (Home Assignments & Quizzes) | (15%) |
| | | Mid semester Examination (1 hour) | (25%) |
| | | End semester Examination (3 hour) | (60%) |

## Course Objectives

To gain an understanding of the fundamental concepts of computer network. Familiarize the student with the basic network protocols, topologies and its applications.

## Course Outcomes

After completing this course the students should be able to:

1. Independently understand basic computer network technology.
2. Explain Data Communications System and OSI model.
3. Understand various routing and flow control mechanisms.
4. Identify the different types of network devices and their functions.
5. Understand the concept of internetworking and functions of different layers of TCP/IP.

## Syllabus

***Unit-I Introduction and Layered Network Architecture***

Growth of Computer Networking; Resource Sharing; Growth of the Internet; Layering; System Design; Network Topology; Packets, Frames and Error Detection.

***Unit-II Multi access Communication***

Introduction; Slotted Multi-access and Aloha Systems; Splitting Algorithms; Carrier Sensing; Multi-access Reservation; Packet Radio Networks.

***Unit-III Routing and Flow Control***

WAN Routing; Interconnected Network Routing; Network Algorithms and Shortest Path Routing; Means of Flow Control; Window Flow Control; Overview of Flow Control in Practice.

***Unit-IV Internetworking***

Concepts, Architecture and Protocols; Internet Protocol Addresses; Binding Protocol Addresses; IP Datagram and Datagram Forwarding; IP Encapsulation, Fragmentation and Reassembly; Error Reporting Mechanism (ICMP); TCP: Reliable Transport Service.

**Text Book(s)/Reference Book(s)**


1. A Leon-Garcia and I. Widjaja, *Communication Networks*, Tata McGraw Hill, 2004.
2. L.L. Peterson & B.S. Davie, *Computer Networks*, Elsevier, 2007.
3. D. Bertsekas & R. Gallager, *Data Networks*, PHI, 1997.
4. B.A. Forouzan, *TCP/IP Protocol Suite*, Tata McGraw Hill, 2005.


**Web Resources**

1. https://www.coursera.org/
2. http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-263j-data-communication-networks-fall-2002/
3. http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-829-computer-networks-fall-2002/
4. http://nptel.iitm.ac.in/courses/IIT-MADRAS/Computer_Networks/index.php

**Relationship of COs with POs**

| **COs** | **POs** | | | | | | | | | | |
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| **Course Number and Title** | **:** | **EL-354 Microwave and Antenna** | |
| Credits | **:** | 4 | |
| Course Category | **:** | Departmental Core | |
| Pre-requisite(s) | **:** | AP-204 Electromagnetics | |
| Contact Hours (L-T-P) | **:** | 3-1-0 | |
| Type of Course | **:** | Theory | |
| Course Assessment | **:** | Course Work (Home Assignment & Quiz) | (15%) |
| | **:** | Mid Semester Exam (01 hour) | (25%) |
| | **:** | End Semester Exam (03 hour) | (60%) |

**Course Objectives**

The course objectives are to familiarize the students about important concept of μwaves to learn how μwaves devices and antennas work and their applications.

**Course Outcomes**

After completing this course the students will be able to**:**

1. Understand basic concepts related to μwave engineering
2. Model microwave components using S-parameters
3. Understand the theory of μwave tubes and solid state devices
4. Identify the different types of antennas and learn their working
5. Analyse different types of antennas

**Syllabus**

***Unit-I Microwave Components and Measurements***

Introduction; Guided –Wave Propagation; Wave-guide Components-Tees, Hybrid Rings; Wave-guide- Tuning, Matching, Loading, and Attenuating Components; Directional Couplers, Isolators, Circulators and Detector, Modeling of Microwave Components-Scattering Parameters and their Properties; Measurements of VSWR, Impedance, Frequency, Wavelength, Attenuation and Power.

***Unit-II Microwave Tubes***

Introduction; Frequency Limitations of Conventional Tubes; Multi-cavity Klystron Amplifiers and Oscillators; Reflex Klystron Oscillators and Their Applegate Diagrams; Magnetrons and Traveling Wave Tubes (TWTs) their Working and Applications.

***Unit-III Microwave Semiconductor Devices***

Introduction; Micro-Strip & Strip Lines; Limitations of Transistor at High Frequencies; Construction, Operation and Applications of Schottky Barrier Diode; Varactor Diode; Tunnel Diode; Gunn Diode; PIN Diode; IMPATT & TRAPATT Diodes; Manley Rowe Relationship and Parametric Amplifiers.

***Unit-IV Antenna***

Introduction; Hertzian Dipole; Half-Wave Dipole Antenna; Quarter-Wave Monopole Antenna; Small-Loop Antenna; Microwave Antenna; Antenna Characteristics; Antenna Arrays-Feed Points, Broad side and End fire Arrays; Multiplication of Patterns; Effect of Ground; Effective Area and Firris Equation; Antenna Classification based on Frequency Range and Applications; Antenna Analysis.

**Text Book(s)/Reference Book(s)**


1. S.Y. Liao, *Microwave Devices & Circuits,* 3rd ed., N. Delhi, Prentice Hall of India, 2003**.**
2. G. Kennedy and B. Davis, *Electronic Communication Systems*, 4th ed. Tata McGraw-Hill, New Delhi, 1985.
3. M.L. Sisodia & V.L Gupta, *Microwaves*, New Age International Publishers, N. Delhi, 2001
4. J. D. Kraus, R.J. Marhefka & A.S. Khan, *Antennas and Wave Propagation*, 4th ed., Tata McGraw-Hill, New Delhi, 2010.
5. C.G. Christodolou, P.F. Wahid, *Fundamentals of Antennas: Concepts and Applications*, PHI, N. Delhi, 2004.
6. M. M. Radmanesh**,** *Radio Frequency and Microwave Electronics—Illustrated*, Pearson Education-2001.


**Web Resources**

1. http://nptel.ac.in/courses/117101056/
2. http://nptel.ac.in/syllabus/syllabus.php?subjectId=117105029
3. http://www.ece.msstate.edu/~donohoe/ece4313.html
4. http://www.ece.nus.edu.sg/stfpage/elehht/Teaching/EE5308R/index.htm
5. http://www.stanford.edu/class/ee252/handouts.html

**Relationship of COs with POs**

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| **Course Number and Title** | : | **EL-380 Colloquium** | |
| Credits | : | 2 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | Communication Skills Lab | |
| Contact Hours (L-T-P) | : | 0-2-0 | |
| Type of Course | : | Seminar | |
| Course Assessment | : | Course Work (Written and Presentation) | (100%) |

## Course Objectives

Expand the scope of students' to various facets of Electronics Engineering Education. Improve student's capability in developing a talk understandable to general audience. Improve student's communication, presentation, writing skills.

## Course Outcomes

After completing this course the students should be able to:

1. Study the technical papers in the emerging and interdisciplinary areas.
2. Develop self-learning skills.
3. Write technical report and defend it through presentation.
4. Understand the professional and ethical responsibility.
5. Acquire knowledge of engineering solutions of contemporary issues on society and environment.

## Relationship COs with POs

| **COs** | **POs** | | | | | | | | | | |
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| **Course Number and Title** | : | **EL-395: Electronics Lab-III** | |
| Credits | : | 02 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | Analog Electronics | |
| Contact Hours (L-T-P) | : | 0-1-2 | |
| Type of Course | : | Laboratory | |
| Course Assessment | : : | Continuous evaluation of each experiment | (40 %) |
| | | Mid semester Test and Viva Voce | (20%) |
| | | End semester Examination (2 hour) | (40%) |

**Course Objectives**

Learn IC based circuit simulation and analysis using ORCAD version-10.3.

**Course Outcomes**

After completing this course the students shall be able to:

1. Able to write Pspice programs, for circuit simulation and analysis.
2. Verify newly developed circuit designs and their IC feasibility.
3. Write effective technical lab reports.
4. Able to express the gained knowledge through lab vivas.

**List of Experiments**

1. Familiarization with ORCAD PSPICE software
2. Write PSPICE program to plot the (i) DC transfer characteristics, (ii) Frequency response, and (iii) Time-domain response of the given RC circuit. Also study the effect of varying various circuit elements.
3. Write PSPICE program to plot the Frequency response of the circuit shown in figure for the given designed values, with a varying load resistor (three values) at the output. Measure Gain and Bandwidth for three different load values. Also find the Q-point of the transistor.
4. Write PSPICE program to perform the transient analysis of the circuit shown in figure for the given designed values and plot input/output waveforms. Also measure %age THD at the output. Modify the circuit to reduce %age THD.
5. Write PSPICE program to plot the currents through differential pair transistors, for varying input voltage for the circuit shown in figure. Also perform transient analysis to plot input/output waveforms. Study the effect of varying transistors' aspect ratios.

6. Write PSPICE program to plot the VTC for the circuit shown in figure. Also perform transient analysis with Pulse input to plot input/output waveforms. Study the effect of varying transistors' aspect ratios.
7. Design the circuit shown in figure for given pole-frequency and quality factor, and verify the design using PSPICE program by plotting the gain (in dB) response. Measure the pole-frequency and quality factor and compare with the designed values.
8. Design Opamp based quadrature oscillator circuit (to be given) for the specified oscillating frequency. Plot the output waveforms and measure the frequency of oscillation. Also plot the Fourier spectrum and measure %THD. Perform MC analysis by assuming 5% tolerance in resistor values.
9. Design the given quadrature oscillator circuit for the frequency of $\mathbf{f_0}$ **kHz** and verify the design using PSPICE program by plotting the outputs of two op-amps. Also plot the FFT of two outputs and calculate the THD.
10. To develop a model for second generation current conveyor (CCII+) and verify it by realizing an amplifier and integrator using the same.

**References**


1. M. H. Rashid, SPICE for circuits and Electronics using PSpice, PHI, 2001.
2. A. S. Sedra, K. C. Smith, Microelectronics, Oxford Univ. Press, 2010.


**Relationship of COs with POs**

| **COs** | **POs** | | | | | | | | | | |
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|---|---|---|---|
| **Course Number and Title** | : | **EL-396 Communication Lab-I** | |
| Credits | : | 2 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | Signals and Systems, Principles of Communication Engineering | |
| Contact Hours (L-T-P) | : | 0-1-2 | |
| Type of Course | : | Laboratory | |
| Course Assessment | : | Continuous evaluation of each experiment<br>Mid semester Test and Viva Voce<br>End semester Examination (2 hour) | (40 %)<br>(20%)<br>(40%) |

**Course Objectives:**

Develop the ability to understand the practical issues related to analog modulation/demodulation and to determine their performance.

**Course Outcomes**

After successfully completion of this course, students shall be able to:

1. Demonstrate the use of various equipment of the lab.
2. Experimentally verify various principles of analog communication.
3. Analyze and interpret the results of experimentation.
4. Prepare an effective lab report and give viva-voce.

**List of Experiments**

The following all eight experiments are to be performed.

1. Determine the amplitudes and frequencies of the first eight harmonics of a symmetrical square waveform. Compare the practical, theoretical and simulation (using MATLAB) results.
2. Plot the modulation characteristic the given AM modulator. Also perform the demodulation to recover the message signal.
3. Determine the typical values of the parameters of the AM signal properly detected by the given Envelope Detector Circuit. Determine its Detection Characteristics.
4. Determine the parameters (free running frequency and control voltage) of the given VCO. Plot its modulation characteristics ($\Delta f$ vs $\Delta v$) and justify that the given circuit is working as the frequency modulator.

5. Study of PLL and its Application as an FM Demodulator.
6. To determine the Selectivity characteristics of an AM Radio Receiver.
7. Determine the velocity of propagation of HF pulses through the given transmission line. Calculate the inductance per meter (L) and the capacitance per meter length (C) of the given line. Also, trace the reflections observed at the other end of the given line terminated into different loads.
8. To measure the attenuation loss in optical fiber.

**Book(s) and Course Material**

1. Lab Manual
2. B. P. Lathi, *Modem Digital and Analog Communication Systems*, 3rd Ed., Oxford Press, 2004.

**Relationship of COs with POs**

| **COs** | **POs** | | | | | | | | | | |
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| **Course Number and Title** | : | **EL-397 Microprocessors Lab** | |
| Credits | : | 02 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | Microprocessors & Microcontrollers | |
| Contact Hours (L-T-P) | : | 0-1-2 | |
| Type of Course | : | Laboratory | |
| Course Assessment | : | Continuous evaluation of each experiment | (40 %) |
| | | Mid semester Test and Viva Voce | (20%) |
| | | End semester Examination (2 hour) | (40%) |

**Course Objectives**

Development of ability to write 8085-processor based assembly language programs for solving problems of varied complexities, along with interfacing of the microprocessor kit with external devices for real world applications.

**Course Outcomes**

After completing this course the students should be able to:

1. Understand Microprocessor kit and Interfacing cards.
2. Develope 8085-based program ming skills, for problem solving.
3. Verify developed programs and interfacing through actual experimentation.
4. Prepare an effective lab report and give viva-voce.

**List of Experiments**

1. Familiarization with Microprocessor training cum development kit based on 8085. To find the (i) second smallest; (ii) second largest number in an array of N numbers.
2. To find the value of expression $x(1+x^2)$, where x is an 8-bit number.
3. To arrange N numbers in (a) Ascending order; (b) Descending order using Bubble sort and Selection sort algorithm.
4. To divide a 16-bit number by an 8-bit number using rotation method.
5. To convert (i) 12 bit binary number into decimal and (ii) 3 digit decimal into binary.
6. To generate square, triangular and arbitrary waveforms using DAC card.
7. To rotate Stepper Motor for various angles and directions.
8. To drive an LED matrix for (i) rolling display, (ii) BCD to Gray code display.
9. To design a voltmeter using ADC card.
10. Familiarization with Microcontroller training cum development kit.

**References**

1. R. S. Gaonkar, *Microprocessor Architecture Programming and Applications with the 8085*, Penram International Publishing (India) Pvt. Ltd., 2008.

**Relationship of COs with POs**

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|---|---|---|---|
| **Course Number and Title** | : | **EL-398 Communication Lab-II** | |
| Credits | : | 2 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | Digital Communication, Microwave and Antennas | |
| Contact Hours (L-T-P) | : | 0-1-2 | |
| Type of Course | : | Laboratory | |
| Course Assessment | : | Continuous evaluation of each experiment | (40 %) |
| | | Mid semester Test and Viva Voce | (20%) |
| | | End semester Examination (2 hour) | (40%) |

**Course Objectives**

Develop the ability to understand the practical issues related to digital communication system.

**Course Outcomes**

After successfully completing this course, the students will

1. Experimental verification and simulation of Digital Communication.
2. Study various data formats and digital modulation schemes.
3. Study of generation and propagation of microwaves.
4. Analyze and interpret the results of experimentation.
5. Prepare an effective lab report and give viva-voce.

**List of Experiments**

The following all eight experiments are to be performed.

1. Study of sampling and reconstruction of signals.
2. Generate a Delta Modulated signal and determine the conditions for slope overload distortion.
3. Study of various Data Formats and Basic Digital Modulation Schemes.
4. Study of BPSK and QPSK Modulation Scheme.
5. Study of (7, 4) block code using MATLAB.
6. Generate PN and Gold sequences of length 3 using SIMULINK. Also, plot their auto-correlation and cross-correlation functions.
7. Determine the frequency and wavelength in a rectangular waveguide working in $TE_{1,0}$ mode. Also, determine the attenuation characteristics of the waveguide.
8. Determine the frequency response of Micro-strip filters.
9. To measure the distortion content of a signal.

**Text Book(s)/References**

1. Lab Manual
2. B. P. Lathi, *Modem Digital and Analog Communication Systems*, 3rd Ed., Oxford Press, 2004.

**Relationship of COs with POs**

| **COs** | **POs** | | | | | | | | | | |
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|---|---|---|---|
| **Course Number and Title** | : | **EL-410 RF System Design** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Elective | |
| Pre-requisite(s) | : | Circuit Theory, Analog Electronics | |
| Contact Hours (L-T-P) | : | 3-1-0 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Course Work (Home Assignment & Quiz) | (15%) |
| | | Mid semester Examination (1 hour) | (25%) |
| | | End semester Examination (3 hour) | (60%) |

## Course Objectives

To gain understanding about recent advancements in field of wireless systems and technologies; familiarize the students about RF electronics, so that they can understand how these systems work; develop specialized skills required for design of these systems.

## Course Outcomes

After completing this course the students will be able to:

1. Independently understand radio frequency (RF) fundamental;
2. Get an exposure to emerging wireless systems;
3. Know the various blocks of wireless systems and how do they work;
4. Identify the low power CMOS devices and their model requirements for RF circuit
5. Developed specialized skill required for design for RF circuits.

## Syllabus

***Unit-I Introduction of RF System***

Overview of RF/wireless systems and their standards; Transmitter and Receiver architectures; Radio Frequency Identification (RFID) system and its applications; Wireless LAN; Wireless PANs; UWB; WiMAX; Basic concepts of Blue Tooth and Software defined radio.

***Unit-IICommunication Circuits***

Integrated circuit requirements for modern RF/wireless system; RF circuits – Low-noise amplifier (LNA) and power amplifier (PA), Oscillators, Mixers; Base band circuits-modulators; Demodulators; Integration issues of RF and base band circuits.

***Unit-III RF CMOS Modeling***

Device options and requirements for modern wireless system; Low Frequency (LF) vs Radio Frequency (RF) model; RF model development; Equivalent circuit model representation; Parameter evaluation; Model verification; Figure-of-Merits (FoMs).

***Unit-IV RF Circuit Design***

Design – Goals and Objectives; Design specifications; Design issues and approach; Circuit design of front-end blocks of wireless system; Performance assessments.

**Text Book(s)/Reference Book(s)**


1. T.H. Lee, *The Design of CMOS Radio Frequency Integrated Circuits*, Cambridge University Press, 2004. **(Text Book)**
2. T. Ytterdal, Y. Chang and T.A. Fjeldly, *Device Modeling for Analog and RF CMOS Circuit Design*, Wiley, 2013.
3. Ulrich L. Rohde and Mathias Rudolph, *RF/Microwave Circuit Design for Wireless Applications*, 2005.
4. Kai Chang, Inder Bahal and Vijay Nair, *RF and Microwave Circuit and Component Design for Wireless System*, Wiley, 2002.
5. B. Razavi, *RF Microelectronics*, 2nd edition Prentice Hall, 2012.
6. J. H. Reed, *Software Radio: A Modern Approach to Radio Engineering*, Pearson, 2004.


**Web Resources**

1. http://freevideolectures.com/Course/2329/Wireless-Communication
2. http://www.youtube.com/watch?v=bur9hq_abog&list=PL33AB52ED9A7873C0&index=38
3. http://www.youtube.com/watch?v=bur9hq_abog&list=PL33AB52ED9A7873C0&index=38
4. http://www.youtube.com/watch?v=-ymnQ5rpcYA
5. http://www.youtube.com/watch?v=KUDGGsyh1Hs

**Relationship of COs with POs**

| **COs** | **POs** | | | | | | | | | | |
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|---|---|---|
| **Course number and Title** | : | **EL-412 Analog IC Design** |
| Credits | : | 4 |
| Course Category | : | Departmental Elective |
| Pre-requisite(s) | : | Analog Electronics, Active Network Synthesis |
| Contact Hours (L-T-P) | : | 3-1-0 |
| Type of Course | : | Theory |
| Course Assessment | : | Course Work (Home Assignments & Quizzes) (15%) |
| | | Mid semester Examination (1 hour) (25%) |
| | | End semester Examination (3 hour) (60%) |

## Course Objectives

To gain an understanding of the principles in designing Analog circuits from integration perspective.

## Course Outcomes

After attending this course, students will be able to:

1. Understand basic analog building blocks and their analysis using models.
2. Design the analog sub-systems.
3. Design circuits with feasibility in IC form.
4. Get exposure to some of the state-of-art techniques and trends in analog design.
5. Develop skills for providing unique workable solutions.

## Syllabus

***Unit-I Design of Analog Building Blocks***

Introduction to analog design, Analog signal processing, Design of MOS analog Switches, active resistors, Design of Voltage and Current references, Current conveyor circuit, Analog Multipliers.

***Unit-II MOS based Amplifiers***

Design of MOS based Inverting amplifiers, BiCMOS Amplifier, CMOS Differential Amplifier, MOS Cascode amplifier, Design of CMOS operational amplifier, Current feedback opamp., GaAs amplifier.

***Unit III Analog Sampled Data Networks***

Switched capacitor concept, Resistor emulation, Design of SC Amplifiers: unity gain ampler/buffer, non-inverting/inverting amplifier, precision multiply-by-two circuit, SC integrators and filters, Programmable capacitor arrays, Field Programmable Analog Arrays.

***Unit IV Circuit Characterization and Layout Techniques***

Analog layout techniques: Multifinger transistors, Symmetry, Common centroid technique, Reference distribution, Pads and ESD protection, Substrate coupling, Properties of IC Components Resistance/Capacitance estimation of MOS devices, Matched cell layout automation.

**Text Book(s)/Reference Book(s)**


1. Phillip E. Allen, and Douglus R. Holberg, *CMOS Analog Circuit Design*, OxfordUniv. Press, 2007.
2. Behzad Razavi, *Design of Analog CMOS ICs*, Tata Mc Graw Hill, 2008.
3. Neil H. E. Weste and K. Eshergian, *Principles of CMOS VLSI Design*, Pearson Edu., 2001.
4. R. L. Geiger et al., *VLSI Design techniques for analog and digital circuits*, Mc Graw Hill, 1990.


**Relationship of COs with POs**

| **COs** | **POs** | | | | | | | | | | |
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| **Course Number and Title** | **:** | **EL-413 Digital IC Design** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Elective | |
| Pre-requisite(s) | : | Logic Circuits, Digital Electronics, VLSI Design & Technology | |
| Contact Hours (L-T-P) | : | 3-1-0 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Course Work (Home Assignments & Quizzes) | (15%) |
| | | Mid semester Examination (1 hour) | (25%) |
| | | End semester Examination (3 hour) | (60%) |

## Course Objectives

To learn the design of digital circuits to satisfy a given specification at the transistor level in deep submicron.

## Course Outcomes

After attending this course, students shall be able to:

1. Understand MOSFET device modelling.
2. Design static/dynamic combinational circuits.
3. Design sequential circuits using different logic styles.

## Syllabus

***Unit-I Introduction to Digital IC Design***

Issues, Cost, Functionality and Robustness; Performance; Power and Energy Consumption, Review of Processing Steps; Behaviour of MOSFET in Digital ICs.

***Unit-II The CMOS Inverter***

Interconnect Parameter and Models; Properties, Static and Dynamic Behaviour of the CMOS Inverter; Power and Energy Considerations.

***Unit-III Combinational Logic Circuits***

Static CMOS Design; Complimentary CMOS; Ratioed and PTL; Dynamic CMOS Design

***Unit-IV Sequential Logic Design and RC Parasitics***

Static Sequential Circuits; Dynamic Sequential Circuit; Capacitive/Resistive Parasitics and Performance.

**Text Book(s)/Reference Book(s)**


1. J.M. Rabacy & others, *Digital Integrated Circuits – A design perspective*, Second edition, Pearson-Prentice Hall, 2002.
2. D.A. Hodges et al, *Analysis and Design of Digital Integrated Circuits*, 3rd edition, Tata McGraw Hill, 2005.
3. Sung-Mo-Kang and Yusuf Lablebici, *CMOS Digital Integrated Circuits*, 3rd edition, Tata McGraw Hill, 2003.


**Relationship of COs with POs**

| **COs** | **POs** | | | | | | | | | | |
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|---|---|---|---|
| **Course Number and Title** | **:** | **EL-415 Digital System Design** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Elective | |
| Pre-requisite(s) | : | Logic Circuits, Digital Electronics, VLSI Design & Technology | |
| Contact Hours (L-T-P) | : | 3-1-0 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Course Work (Home Assignments & Quizzes) | (15%) |
| | | Mid semester Examination (1 hour) | (25%) |
| | | End semester Examination (3 hour) | (60%) |

## Course Objectives

To learn the design of digital systems to satisfy a given specification in deep submicron.

## Course Outcomes

After successfully completing this course, students will be able to

1. Understand design flow of digital systems using industry standard electronic design automation tools.
2. Learn Verilog HDL for the modelling of Digital systems at a high level.
3. Introduction to implementation technologies like ASICs and FPGA.
4. Describe Digital system in terms of Data subsystem and Control subsystem.

## Syllabus

***Unit-I Verilog HDL***

VLSI Design Problem, IC Design Hierarchy, Introduction to Verilog, Structural, Behavioral and Dataflow Modelling, Simulation Based Verification, Concept of Assertion Based Verification and Formal Verification, Concept of Synthesis, FSM Coding

***Unit-II Design of RTL Systems***

RTL Systems: Organization, Specification and Implementation, Analysis of RTL Systems and Design Examples, Implementation Technologies: Standard Cell ASIC, EPLDs and FPGAs

***Unit-III Data and Control Subsystem***

Data Subsystem Modules: Storage, Function and Data path; Control Subsystem; Micro-Programmed Controller; Structure, Format and Design.

***Unit-IV Implementation of a Microcomputer***

Architecture and Implementation of a Simple Microcomputer System; Operation of the System, Processor Implementation in Verilog

**Text Books/Reference Books:**


1. Milos Ercegovac et.al, *Introduction to Digital System*, John Wiley & Sons, 2000.
2. M. D. Ciletti, *Advanced Digital Design with the Verilog HDL*, Prentice Hall of India, 2008.


**Relationship of COs with POs**

| **COs** | **POs** | | | | | | | | | | |
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| **Course Number and Title** | : | **EL-447 Multimedia Systems and Networks** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Elective | |
| Pre-requisite(s) | : | Digital Communication | |
| Contact Hours (L-T-P) | : | 3-1-0 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Course Work (Home Assignments & Quizzes) | (15%) |
| | | Mid semester Examination (1 hour) | (25%) |
| | | End semester Examination (3 hour) | (60%) |

## Course Objectives

To gain an understanding of the fundamental concepts of Multimedia. Familiarize the student with the basic multimedia networks, transmission standards and its applications.

## Course Outcomes

After completing this course the students should be able to:

1. Independently understand basic multimedia systems, components and devices.
2. Comprehend basic issues relating to text and still images, including their coding and compression techniques.
3. Understand basic issues relating to audio video coding and Transmission standards.
4. Understand the concepts of Networked multimedia, timing relationships and WWW.

## Syllabus

***Unit-I Introduction***

Brief History; Basic definitions; New Media elements; Characteristics of Multimedia Systems; Classification of Media; Multimedia System and Components; Evolution of Enabling Technologies for Multimedia; Electronic pen; flat panel displays; Handwriting and speech recognition; Multimedia Applications.

***Unit-II Text and Image Coding & Transmission Standards***

Basics of Text; Repetition Suppression; Statistical Encoding; Dictionary Modeling; LZ and LZW Coding; Image Basics; Types of Image; Image Representation; Colour Models; Image Processing; Compression of Binary Images and its standards; Compression of Gray Scale & Colour Images; JPEG, JPEG2000

***Unit-III Audio & Video Coding & Transmission Standards***

Basics of Audio; Audio Compression & its Standards; MPEG-1, MPEG-2 and MPEG-4 Audio; Basics of Video; Brief overview of Analog TV; Digital Video; High Data Rate & Low Data Rate

Digital Video Formats; Principles of Video Compression; Types of frames in a compressed video sequence; MPEG-1, MPEG-2 and MPEG-4 & other Video Communication Standards

***Unit-IV Networked Multimedia***

Timing Relationships in Networked Multimedia; Video Conferencing & Video on Demand &their Standards; Standards for Interactive Applications over Internet. Entertainment Networks; World Wide Web.

## Text Book(s)/Reference Book(s)


1. Fred Halsall, *Multimedia Communications*, Pearson Education (Low Priced ed.), 2002.
2. Ranjan Parekh, *Principles of Multimedia Systems*, Tata McGraw Hill, 2006.
3. Nalin K. Sharda, *Multimedia Information Networking*, Pearson Education, 1999.


## Web Resources

1. https://www.coursera.org/
2. http://nptel.ac.in/courses/Webcourse contents/IIT%20Kharagpur/Multimedia%20Processing/New index1.html

## Relationship of COs with POs

| COs | POs | | | | | | | | | | |
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|---|---|---|
| **Course Number and Title** | : | **EL-456 Fiber Optic Communication** |
| Credits | : | 4 |
| Course Category | : | Departmental Elective |
| Pre-requisite(s) | : | Basic Electronics, Principals of Communication Engineering |
| Contact Hours (L-T-P) | : | 3-1-0 |
| Type of Course | : | Theory |
| Course Assessment | : | Course Work (Home Assignments & Quizzes) (15%)<br>Mid semester Examination (1 hour) (25%)<br>End semester Examination (3 hour) (60%) |

## Course Objectives

To gain an understanding of the fundamental concepts of Fiber optic communication. Familiarize the student with the optical fibers, modulation and demodulation schemes and optical networking.

## Course Outcomes

After completing this course the students should be able to:

1. Independently understand basic Fiber Optic Communication.
2. Explain modulation and detection techniques.
3. Understand the optical networking.

## Syllabus

***Unit-I Optical Fibers***

Review of Optical Fibers; Ray Model; Numerical Aperture of Step Index and Graded Index Fibers; Power Coupling; Normalized Frequency; V Number and Modes in Multi-Mode Fibers, Propagation Constant & Its Effective Value; Mode Groups; Normalized Propagation Constant, Inter-modal & Intra-modal Dispersion, Single Mode Fibers; Dispersion Shifted and Dispersion Flattened Fibers; Introduction to Polarization Maintaining Fibers.

***Unit-II Intensity Modulation/Direct Detection Techniques***

Attenuation Management and Fiber-optic Amplifiers; Dispersion Management and Techniques; System Design Consideration; Digital Systems: Receivers, Probability of error, Power Budgeting; Analog Systems: Direct Intensity Modulation, Sub-carrier Intensity Modulation, Sub-carrier Frequency Modulation; Noise Performance.

***Unit-III Coherent Optical Communication Systems***

Basic System; Detection Principles; Practical Constraints; Modulation and Demodulation Schemes; Receiver Sensitivities-Probability of Error Calculations; Performance Comparison.

***Unit-IV Optical Networking***

Fiber Optic Link Design; Distribution Systems; Multiplexing/ Demultiplexing Components Techniques; Time Division Multiplexing; SONET/SDH; Optical Add/Drop Multiplexing; Wave Division Multiplexing; WDMA – Single Hop and Multiple Hop Networks

**Text Book(s)/Reference Book(s)**


1. G. Keiser, Optical Fiber Communication, Tata McGraw Hill, 2013.
2. J. M. Senior, Optical Fiber Communications, Pearson Education, 2010.
3. G. P. Agrawal, Fiber Optic Communication Systems, John Wiley & Sons, 2002.
4. M.M.K. Liu, Principles and Applications of Optical Communication, Tata McGraw Hill.


**Web Resources**

1. https://www.coursera.org/
2. http://www.cdeep.iitb.ac.in/nptel/Electrical%20&%20Comm%20Engg/Optical%20Communication/Course%20Objective.htm
3. http://ocw.mit.edu/resources/res-6-005-understanding-lasers-and-fiberoptics-spring-2008/

**Relationship of COs with POs**

| **COs** | **POs** | | | | | | | | | | |
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|---|---|---|
| **Course Number and Title** | : | **EL-457 Mobile Communication** |
| Credits | : | 4 |
| Course Category | : | Departmental Elective |
| Pre-requisite(s) | : | Digital Communication, Communication Networks |
| Contact Hours (L-T-P) | : | 3-1-0 |
| Type of Course | : | Theory |
| Course Assessment | : | Course Work (Home Assignments & Quizzes) (15%)<br>Mid semester Examination (1 hour) (25%)<br>End semester Examination (3 hour) (60%) |

## Course Outcomes

After successfully completing this course, the students will be able to:

1. Identify the challenges and possible solutions for wireless communication
2. Determine the characteristics of a wireless channel
3. Calculate the performance of a wireless communication system
4. Describe the principles of cellular mobile system
5. Compare some of the existing and emerging wireless systems and standards

## Syllabus

***Unit-I Cellular System Fundamentals***

Overview of Wireless Communication; Frequency Reuse and Cellular Concept; Co-Channel and Adjacent Channel Interferences; Cell Sectoring and Cell Splitting; Handoff Strategies; Channel Assignment Techniques

***Unit-II Propagation Modeling***

Propagation Path Loss; Shadowing; Path Loss Models; Multipath Fading; Narrowband Fading Models: Correlation and Power Spectral Density, Envelope and Power Distribution, Level Crossing Rate (LCR) and Average Fade Duration (AFD), Wideband Channel Models: Power Delay Profile, Coherence Bandwidth, Doppler Power Spectrum and Channel Coherence Time

***Unit-III Modulation and Multiple Access Techniques***

Performance of Digital Modulation over Wireless Channel; Diversity Techniques, Orthogonal Frequency Division Multiplexing (OFDM); Multiple Access Techniques: Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA), Hybrid Techniques, OFDMA

***Unit-IV Mobile Systems and Standards***

Global System for Mobile Communications (GSM); CDMA Cellular System (IS-95); Evolution of Second-Generation (2G) Systems; Third-Generation (3G) Systems; Beyond 3G Systems

**Text Book(s) and Course Material**

1. Lecture Slides
2. A. S. Goldsmith, *Wireless Communications*, Cambridge University Press, 2005.
3. T. S. Rappaport, *Wireless Communications: Principles and Practice*, Pearson Ed. India, 2002.

**Other References**

1. J. Schiller, *Mobile Communications*, Pearson Education India, 2nd Edition, 2008.
2. A.F. Molisch, *Wireless Communications*, John Wiley & Sons Ltd., 2nd Edition, 2011.
3. J.W. Mark and W. Zhuang, *Wireless Communications and Networking*, PHI, 2005.
4. G. L. Stuber, *Principles of Mobile Communication*, Springer, 3rd Edition, 2011.
5. http://nptel.ac.in/video.php?subjectId=117102062

**Relationship of COs with POs**

| **COs** | **POs** | | | | | | | | | | |
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|---|---|---|
| **Course Number and Title** | : | **EL-490A Project** |
| Credits | : | 4 |
| Semester | : | VII |
| Course Category | : | Departmental Core |
| Pre-requisite(s) | : | …… |
| Contact Hours (L-T-P) | : | 0-2-4 |
| Type of Course | : | Project |
| Course Assessment | : | Course Work (Presentations, Demo and Report) (60%)<br>End semester Examination (40%) |

## Course Objectives

To understand real world problems and solve them effectively with team spirit. To appreciate needs of society, sustainability, ethical and professional issues.

## Course Outcomes

After completing this course the students should be able to:

1. Identify, analyse and formulate real world problems.
2. Apply the knowledge and skills gained in previous courses to solve engineering problems effectively.
3. Develop written and oral presentation skills.
4. Work independently as well as in team.
5. Think innovatively to solve and manage engineering problems effectively.

## Relationship of COs with POs

| **COs** | **POs** | | | | | | | | | | |
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|---|---|---|
| **Course Number and Title** | : | **EL-490B Project** |
| Credits | : | 4 |
| Semester | : | VIII |
| Course Category | : | Departmental Core |
| Pre-requisite(s) | : | …….. |
| Contact Hours (L-T-P) | : | 0-2-4 |
| Type of Course | : | Project |
| Course Assessment | : | Course Work (Presentations, Demo and Report) (60%)<br>End semester Examination (40%) |

## Course Objectives

To understand real world problems and solve them effectively with team spirit. To appreciate needs of society, sustainability, ethical and professional issues.

## Course Outcomes

After completing this course the students should be able to:

1. Apply the knowledge and skills gained in previous courses to solve engineering problems effectively.
2. Develop written and oral presentation skills.
3. Work independently as well as in team.
4. Think innovatively to solve and manage engineering problems effectively.
5. Develop a professional and ethical approach towards solving the needs of society in sustainable manner.

## Relationship of COs with POs

| **COs** | **POs** | | | | | | | | | | |
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| **Course Number and Title** | : | **EL-493 Electronics Lab-IV** |
| Credits | : | 02 |
| Course Category | : | DC |
| Pre-requisite(s) | : | VLSI Design & Technology, Electronics Lab - I, Instrumentation Lab |
| Contact Hours (L-T-P) | : | 0-1-2 |
| Type of Course | : | Laboratory |
| Course Assessment | : | Continuous evaluation of each experiment (40 %)<br>Mid semester Test and Viva Voce (20%)<br>End semester Examination (2 hour) (40%) |

**Course Objectives**

Development of ability to write verilog codes for different digital circuits and simulate using Xilinx tools; Ability to design and experimentally verify the functioning of analog circuits/ICs.

**Course Outcomes**

After completing this course the students should be able to:

1. Learn the Xilinx tools for simulation of Verilog code.
2. Write the verilog code of test bench for different combionational and sequential circuits.
3. Experimentally verify the operation of various analog circuits.
4. Design and test analog circuits using commercially available ICs.

**List of Experiments**

1. Design and experimentally verify a Quadrature Oscillator for given frequency $f_0$ using OPAMP.
2. Design and verify the bi-phase amplifier as (a) Half-Wave Precision Rectifier (b) Full-Wave Precision Rectifier.
3. Design and verify the OPAMP based multifunction filter to realize low-pass and high-pass responses for given cut-off frequency $f$o = ----------kHz.
4. Design and verify the OTA-C based multifunction filter to realize low-pass and high-pass responses for given cut-off frequency $f_o$ = ----------kHz.
5. Design an all pass section using CFA (AD-844) for a pole frequency $\omega_p$ (=$\omega_z$) = 2 $\pi f_0$ ($f_0$ = gp-no KHz). Plot the frequency response of the designed AP section (*magnitude and phase of $V_{02}$ with respect to $V_i$,* versus frequency).

**Text Books/Reference Books:**


1. M. D. Ciletti, *Advanced Digital Design with the Verilog HDL*, Prentice Hall of India, 2008.
2. M. M. Mano and M. D. Ciletti, *Digital Design*, 4$^{th}$ed. 2007, Pearson.

3. Sedra Smith, *Microelectronic Circuits*, Oxford University Press, 2005.

**Relationship of COs with POs**

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| 3 | | | X | X | | X | | | | | |
| 4 | | | X | X | | X | X | | | | |

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|---|---|---|---|
| **Course Number and Title** | : | **EL-494 Communication Lab-III** | |
| Credits | : | 2 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | EL-342, EL-354, EL-343 | |
| Contact Hours (L-T-P) | : | 0-1-2 | |
| Type of Course | : | Laboratory | |
| Course Assessment | : | Continuous evaluation of each experiment | (40 %) |
| | | Mid semester Test and Viva Voce | (20%) |
| | | End semester Examination (2 hour) | (40%) |

## Course Objectives

Develop the ability to understand the practical issues related to digital communication and DSP.

## Course Outcomes

After successfully completing this course, the students will

1. Study experimental/through simulation the base-band and pass-band communication issues.
2. Determine the radiation patter of antenna.
3. Hands on experience on TI DSP Starter Kit.
4. MATLAB program to study image/signal processing operations.

## List of Experiments

The following all eight experiments are to be performed.

1. Draw the radiation pattern of horn antenna, parabolic dish antenna, and E-plane Tee.
2. Study the Direct Sequence Spread Spectrum (DSSS) using LFSR and generate Gold codes.
3. Study of 16-level QAM and plot its constellation diagram.
4. Write Matlab code to draw the eye pattern of given message sequence, passed through LPF of specified bandwidth. Add white Gaussian noise to baseband signal and draw the eye diagram. Also measure Noise Margin and sensitivity from the eye diagram.
5. Obtain a 16×16 pixel matrix g(m,n), m= 1,2 ,……, N; n=1,2, ……, N consisting of 256 pixels, with each pixel quantized to only 2 levels, 0 and 1. Obtain the 16×16 transition matrix h(m,n) by sampling the following continuous function h(x,y) = $\frac{e^{-jk\sqrt{x^2+y^2+z^2}}}{\sqrt{x^2+y^2+z^2}}$ ,

for k=2 and z=0.01. Sample the function in the interval $-8 \leq x \leq 7$, $-8 \leq y \leq 7$. Obtain the degraded image $f(m,n) = g(m,n) \otimes h(m,n) + \eta(m,n)$, where $\eta(m,n)$ is a 16×16 random noise matrix having a maximum value of an element is 0.3.

6. Implement a 16-tap bandpass FIR filter on DSK6416 for a sampling rate of 16 KHz using Hamming window. The passband should extend from 2000 Hz to 5000 Hz. Plot the amplitude and phase response.
7. Write a C program to calculate the N (complex data) point DFT using decimation-in-time FFT algorithm on DSK5510 and hence find 8-point DFT of sequence $x(n)=\begin{Bmatrix}1; n = 0,1,2,3\\0;\ otherwise\end{Bmatrix}$.
8. Implement a 16-tap lowpass FIR filter on DSK6416 for a sampling rate of 16 kHz using Hamming window with cutoff frequency 3000 Hz. Plot the amplitude and phase response. Write a Matlab program to study the up-sampling operation of a sinusoidal signal. Program should ask the following inputs: input's length N, input signal frequency f0 and up-sampling factor L. Plot the input and output sequences for N=50, f0=0.35 and L=4.
9. A polynomial expression suggested for approximation of arctangent of a number x is in the range $-1 \leq x \leq 1$ is given by:
   $\tan^{-1}(x/\pi) \tilde{=} 0.318253x + 0.003314x^2 - 0.130908x^3 + 0.068542x^4 - 0.009159x^5$.
10. Compute and plot the values of tan-1(x) from the above expression and the error due to the approximation.

**Text Book(s)/References**


1. Lab Manual
2. B. P. Lathi, *Modem Digital and Analog Communication Systems*, 3rd Ed., Oxford Press, 2004.
3. S.K. Mitra, Digital Signal Processing: A Computer-Based Approach, 4/e, Tata McGraw Hill Education, 2011


**Relationship of COs with POs**

| COs | POs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i | j | k |
| 1 | | | | X | X | | | X | X | | |
| 2 | | | | X | | | | X | X | | |
| 3 | | | | X | | | | X | X | | |
| 4 | | | | X | X | | | X | X | | |

| | | |
|---|---|---|
| **Course Number and Title** | : | **EL-432N Artificial Intelligence and Neural Network** |
| Credits | : | 4 |
| Course Category | : | Open Elective |
| Pre-requisite(s) | : | -- |
| Contact Hours (L-T-P) | : | 3-1-0 |
| Type of Course | : | Theory |
| Course Assessment | : | Course Work (Home Assignments & Quizzes) (15%)<br>Mid semester Examination (1 hour) (25%)<br>End semester Examination (3 hour) (60%) |

## Course Objectives

To understand the fundamentals of artificial intelligence and artificial neural network. Familiarize the student with AI search techniques, Logic programming, mathematical model of biological neuron, different types of ANNs, their applications.

## Course Outcomes

After completing this course the students shall be able to:

1. Understand the basics of AI and ANN.
2. Solve basic AI problems using different search techniques.
3. Learn and apply logic systems for automated reasoning.
4. Learn basic ANN architectures and design ANN for solution of some simple computational problems.
5. Describe how ANN can be applied in various fields of technology including bioinformatics, communication etc.

## Syllabus

***Unit-I Introduction to AI and Search Techniques***

Foundation of AI, Rational Agents, Problem Solving Agents: Search Strategies – Breadth-first Search, Depth-first Search, Depth-limited Search, Iterative Deepening Depth-first Search, Bidirectional Search, Greedy Best-first Search, A* Search, Hill Climbing, Simulated Annealing, Alpha-Beta Pruning, Minimax Algorithm.

***Unit-II Knowledge and Reasoning***

Prepositional Logic; First Order Predicate Logic (FOPL); Inference Rules; Resolution, Rule Based Systems – Forward Reasoning, Conflict Resolution, Backward Reasoning; Logic Programming, Introduction to Logic Programming Language (PROLOG).

***Unit-III Fundamentals of ANN***

Biological Neuron; Introduction to ANN; Artificial Neuron, Activation Functions. Single Layer Perceptron, Limitations of Single Layer Network, Linearly Separable Problems. Multi Layer Perceptron, Learning and Back-propagation; Radial Basis Function Networks; Feedback Neural Networks.

***Unit-IV ANN Applications***

Applications of ANN in Bioinformatics, Forecasting, Healthcare, Intrusion Detection, Communication, Robotics, Image Processing and Compression, Control, Pattern Recognition, Optimization.

**Text Book(s)/Reference Book(s)**


1. Stuart J. Russel & Peter Norvig, "Artificial Intelligence: A Modern Approach", 3rd Edition, PHI, 2009.
2. Elaine Rich & Kevin Knight, "Artificial Intelligence", TMH, 2005.
3. Jacek M. Zurada, "Introduction to Artificial Neural Systems", Jaico Publishing House, 2012.
4. Sivanandam, S. N. Deepa, "Introduction to Neural Networks Using Matlab 6.0", TMH, 2006.


**Relationship of COs with POs**

| **COs** | **POs** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i | j | k |
| 1 | X | | | | | | | | | | |
| 2 | X | X | X | | | | | | | | |
| 3 | | | | | X | | | | | | |
| 4 | X | X | X | | X | | | | | | |
| 5 | | | X | | X | | X | | | | |

| **Course Number and Title** | | **EL-320 Industrial Electronics & Instrumentation** |
|---|---|---|
| Credits | : | 4 |
| Course Category | : | Open Elective |
| Pre-requisite(s) | : | |
| Contact Hours (L-P-T) | : | 3-0-1 |
| Type of Course | : | Theory |
| Course Assessment | : | Course Work (Home Assignments & Quizzes) (15%) |
| | | Mid-semester Examination (1 hour) (25%) |
| | | End-semester Examination (3 hour) (60%) |

## Course Objectives

To enable students to comprehend, analyze, and design electronic systems for industrial applications.

## Course Outcomes (CO)

After completion of this course, students shall be able to:

1 Apply the knowledge of electronic circuits for industrial applications.
2 Analyse and design general purpose electronic test equipment.
3 Understand the architecture of Microcomputers.
4 Able to solve real world problems using embedded systems;

## Syllabus

***Unit-I Data Acquisition and Conversion***

Introduction to Data Acquisition System, Encoders, Decoders, BCD to 7-Segment Decoder/Driver, Multiplexers, Demultiplexers, Flips Flops, Counters, A/D & D/A Converters.

***Unit-II General Purpose Electronic Test Equipment***

Basic Principles of Digital Voltmeter, Frequency Measurement, Function Generators, Regulated Power Supply, and DSO, Transducers for the Measurement of Non-Electrical Quantities; Concept of Actuator.

***Unit-III Basic Microcomputer Organisation***

Basic Computer System Organization; Typical Microcomputer Structure and Bus System, Overview of Microprocessor Architecture; ROM and RAM.

***Unit-IV Applications of Microcomputers in Industries***

Interfacing of Microcomputers with the Real World; Temperature Monitoring and Control; Introduction to Microcontrollers, Application of Microprocessor/ Microcontroller in Industry (Real example from Automated Industrial Plants).

**Book(s)/ Text Book(s):**


1. H.S Kalsi , *Electronic Instrumentation*, , Tata McGraw Hill, 3rd, Edition (fourth reprint 2012).
2. W.D. Cooper and A.D Helfrick, *Electronic Instrumentation and Measurement Techniques*, Prentice Hall of India Pvt. Ltd., New Delhi
3. David A. Bell, *Electronic Instrumentation and Measurements,* Second Edition, PHI, 2007.
4. A.K Sawhney, *A Course in Electrical and Electronic Measurements and Instrumentation*, Dhanpat Rai & Co, New Delhi, 19th, Revised Edition 2011(Reprint 2012).
5. R. J. Tocci, N. S. Widmer, and, G. L. Moss, *Digital Systems, Principles and Applications*, Pearsons, 10th Edition, New Delhi, (Re-print 2013).


**Relationship of COs with POs**

| **COs** | **POs** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i | j | k |
| 1 | X | X | X | | | | | | | | |
| 2 | X | X | | X | | | | | | | |
| 3 | X | | | | X | | | | | | |
| 4 | X | X | X | X | X | | X | | | | X |

# M. TECH PROGRAM

## ELECTRONIC CIRCUITS & SYSTEM DESIGN

# ORDINANCES (ACADEMIC) CHAPTER - XXXVI (E)

**Master of Technology in the Faculty of Engineering & Technology (Effective from the Session 2011 – 2012)**

## 1. Introduction

(b) The Faculty of Engineering & Technology, Aligarh Muslim University offers full-time program leading to the Master of Technology (M. Tech.) degree in Chemical Engineering, Civil Engineering, Computer Science and Engineering, Electrical Engineering, Electronics Engineering, Mechanical Engineering, Petroleum Processing and Petrochemical Engineering, and Nanotechnology, with further specializations, if any.

(c) The medium of instruction in M. Tech. Program is English.

### (a) Eligibility

A candidate will be eligible for admission to M. Tech. program if he/she has obtained the Bachelor of Technology degree or its equivalent recognized by the University in the relevant branch of engineering with not less than 60% marks in the aggregate or its equivalent CPI/CGPA/NAG. For M. Tech. program in Nanotechnology, candidates who have obtained Master of Science degree or its equivalent recognized by the University in the relevant subject with not less than 60% marks in the aggregate or its equivalent CPI/CGPA/NAG will also be eligible. All eligibility requirements are subject to such other conditions as laid down by the University from time to time.

Local professionally employed personnel such as working engineers, scientists and teachers may also be admitted as part-time students to the M. Tech. program in the relevant branch, over and above the sanctioned intake.

### (b) Admission

(a) The admissions to the M. Tech. programs will be made normally in the Autumn Semester as per the admission policy approved by the Academic Council of the University from time to time. The admission of each student will be made in a particular branch.

(b) The admission of a candidate will be made either as a full-time student or as a part-time student.

## 4. Academic Session

The academic session is divided into two regular semesters – Autumn and Winter, each of which shall be of approximately 20 weeks duration. The Autumn semester will normally commence in the month of July/August every year, and the Winter in the month of December/January. In the beginning of every session the Dean, in consultation with the Chairmen of the departments concerned, shall notify a detailed academic calendar indicating the schedule of teaching, examination, and other activities.

## 5. Duration of the Program

### 5.1 Minimum Duration

The minimum duration of the program for a full-time student shall be four consecutive semesters after admission. The minimum duration of the program for a part-time student shall be six consecutive semesters

after admission.

### 5.2 Maximum Duration

The maximum duration of the program for a full-time student shall be eight consecutive semesters after admission. The maximum duration of the program for a part-time student shall be ten consecutive semesters after admission.

### 5.3 Minimum and Maximum Duration in case of change of student status

A full-time student can convert his/her admission to part-time subject to his/her fulfilling the eligibility conditions as provided in these ordinances for part -time candidates by applying to the Dean of the Faculty through the Chairman of the concerned department. Such conversion will be allowed at the end of a semester only and not in the middle of the semester. The minimum and maximum durations for such a student shall remain unchanged if such conversion is done after spending two semesters after admission to the program. However, if such conversion is done before spending two semesters after admission, the minimum and maximum durations shall become as specified for part-time students.

## 6. Curriculum and Credit System

### 6.1 Credit System

Each M. Tech. program will have a curriculum in which every course will be assigned certain credits reflecting its weight and contact periods per week, as given below:

1 Lecture period (L) per week = 1 Credit
1 Practical period (P) per week = 1 Credit
1 General period (G) per week = 1 Credit

In addition to theory and laboratory courses there may be other courses such as seminar, colloquium, project, dissertation etc., which will be assigned credits as per their contribution in the program without regard to contact periods. The general period may be used for lecture, presentation, field work, literature search, discussions, software development, or for such other purposes as may be decided by the teacher(s) concerned.

### 6.2 Coordinators and Curriculum Development Committee

There shall be a Chief Coordinator, M. Tech. Programs, to be nominated by the Dean, and a Coordinator, M. Tech. Program in each department, to be nominated by the Chairman of the department concerned. Normally the Chief Tabulator will be the Chief Coordinator, M. Tech. Programs. There shall also be a standing Curriculum Development Committee (CDC), to be constituted by the Faculty. The Chief Coordinator, M. Tech. Programs will be the Convener of the CDC.

### 6.3 The Curriculum Structure

The curriculum for each branch/specialization will contain a listing of all courses, with each course having a course number, course title, number of contact periods per week, number of credits assigned, and the marks assigned to various components of evaluation. It will also have a list of alternative courses in the new curriculum for the old curriculum courses and filler courses to compensate for the shortfall in credits earned by taking alternative courses in any category, if needed. It will also specify all other conditions required for the award of degree.

### 6.4 Approval of the Curriculum

The curriculum for each branch/specialization of M. Tech. program will be prepared by the department concerned and will be approved by the Board of Studies of the department. It will then be vetted by the CDC and will then be placed in the Faculty along with the recommendations of the CDC for approval. Once approved by the Faculty, the Curriculum will be implemented. The same procedure shall be used for any modification in the Curriculum.

## 7. Registration

(a) Every student is required to register, in each semester, for the courses that he/she wants to pursue in that semester. The registration schedule will be announced by the Dean/Chairman for every semester. The registration process involves:
   1 Submitting a registration form in the office of the Chairman and obtaining a registration card signed by the Chairman;
   2 Paying the required fees.

(b) A student will normally register for higher semester courses only if he has also registered for uncleared courses of previous semesters.

(c) A student will have the option to add/delete/alter the courses in his/her registration within a week of the registration subject to such conditions as may be imposed by the department concerned from time to time.

(d) A student can drop a course from his/her registration by submitting a request to his/her department coordinator up to a date specified on his/her registration card. A registered course will be counted as an attempt even if the student remains absent in the Examination(s).

(e) A student may be denied registration in a course due to reasons of paucity of staff or space or other facilities, especially in case the student is registering a course for improving the grade in a passed course.

(f) If a student fails to register in two consecutive semesters without specific permission from the Dean, his/her name may be removed from the rolls of the faculty. Such a student may apply to the Dean for re-admission stating the reasons for not being able to register for two consecutive semesters and the Dean will take suitable decision on the merit of the case.

(g) No student will be allowed to register for more than 28 credits in a semester.

**8. Attendance (In lieu of Chapter XVII of the Academic Ordinances)**

Attendance in each course separately is compulsory at least once. Students who have put in 75% or more attendance in a course in a semester will be eligible to appear in the End-Semester Examination of that course. Students who have put in 65% or more but less than 75% attendance in a course may be considered for condonation of shortage of attendance in that course by the condonation committee. Students whose attendance in a course is less than 65% or whose shortage in attendance has not been condoned will not be eligible to appear in the End-Semester Examination of that course and will be awarded grade 'F' in that course and all marks obtained in any component of the courseevaluation will stand cancelled. However, in case a student is repeating a course and the student has already fulfilled the attendance requirement in that course, he/she will not be detained due to shortage of attendance in that course during the repeating semester.

**9. Examination and Evaluation**

**9.1 Components of Evaluation**

Each course will be evaluated out of 100 marks. The courses will normally have the following components of evaluation:

(a) Theory courses:

| | |
|---|---|
| Course work | 15 marks |
| Mid-Semester Examination | 25 marks |
| End-Semester Examination | 60 marks |

(b) Laboratory courses including Seminar, Colloquium, Project, dissertation etc.

| | |
|---|---|
| Course work | 60 marks |
| End-Semester Examination | 40 marks |

However, for special academic reasons, some courses may have different weight for different components of evaluation from that given above. Such special reasons will be spelt out clearly in the curriculum.

**9.2 Grading System**

The combined marks obtained by a student in various components of evaluation of a course shall be converted into regular letter grades with their equivalent grade points as specified below:

| Grade | Grade Points | Description |
|---|---|---|
| A | 10 | Outstandin g |
| B | 8 | Very good |
| C | 6 | Good |
| D | 4 | Satisfactory (Minimum Pass Grade) |
| E | 2 | Unsatisfactory (Fail) |
| F | 0 | Detained due to shortage of attendance |
| I | 0 | Incomplete/Absent in the End-Semester Examination |
| Z | 0 | Cancelled due to other reasons |

The following marks ranges may ordinarily be used for the award of grades to the students in a course.

| Range | Grade |
|---|---|
| 75 and above | A |
| 60 and above but less than 75 | B |
| 45 and above but less than 60 | C |
| 35 and above but less than 45 | D |
| Less than 35 | E |

Two grace marks may be awarded by the examiner for passing a course and one grace mark may be awarded by the examiner to elevate the grade. Any fraction in any component of evaluation should be rounded off to the next whole number. The examiner(s) may propose higher or lower grade ranges depending upon the nature of the course and general performance of the students in the course, but the final decision rests with the Result Moderation Committee. However, the minimum passing grade `D` should never be awarded if a student secures below 35 marks (including 2 grace marks) in a course.

**9.3 Earned Credits (EC)**

If a student passes a course by obtaining grade D or above he/she earns the credits assigned to that course.

**9.4 Performance Indices**

At the end of every semester a student's performance will be indicated by Earned Credits (EC), a Semester Performance Index (SPI), and a Cumulative Performance Index (CPI). The SPI is the credit-weighted average of grade points of all courses registered during a semester and is computed as follows:

$$SPI = (C1G1 + C2G2 + \ldots\ldots) / (C1 + C2 + \ldots\ldots.)$$

Where C1, C2, ….. are the credits assigned to courses and G1, G2, …… are the grade points earned in those courses.
The CPI is the credit-weighted average of grade points of all courses passed in all the semesters since admission.

**9.5 Repetition of a Failed Course**

If a student fails in a course his/her marks of all components of evaluation in that course will be cancelled. The student will have to register the course again or its alternative and will be required to appear in all components of evaluation afresh. No previous marks shall be used in any case.

**9.6 Repetition of a Passed Course**

A student may repeat a course to try to improve his/her grade in that course only once, provided that he/she has passed that course in a single attempt. In such case the student will have to register the course again and will be required appear in all components of evaluation afresh. No previous marks shall be used in any case. For the purpose of calculating the SPI the recently obtained grade will be considered while for CPI the better of the two grades will be counted.

**9.7 Conduct of** Examinations

(a) The examiners for the End-Semester Examination of all theory courses will normally be the teacher(s) associated with the course. The Seminar, Colloquium courses will be examined by the teacher(s) associated with the course and one or more examiners from among the teachers of the department to be recommended by the BOS of the department concerned. The laboratory and project courses will be examined by the teachers(s) associated with the course and an external examiner not in the service of the university at the time of examination. In case the external examiner does not turn up for the examination, the Chairman of the department concerned, in consultation with the course incharge, shall call another person to act as the external examiner, even from within the University, if necessary.

(b) The dissertation will be submitted after all other components of the M. Tech. Program are completed. The dissertation will be examined by the supervisor(s) and an external examiner not in the service of the university at the time of examination.

**9.8 Moderation Committees**

(a) Question Paper Moderation Committee: There shall be a Moderation Committee of the concerned Department consisting of the following members to moderate the Question Papers of the End-Semester Examination.
   (i) Chairman of the Department concerned – (Convener)
   (ii) One senior teacher of the Department in each broad area of specialization (to be appointed by the BOS).

Note: The Paper Setter(s) may be invited, if necessary, to clarify the necessary details of the question paper.

(b) Result Moderation Committee: There shall be a Result Moderation Committee of the concerned Department consisting of the following members to moderate course-wise results of the End-Semester Examinations.
   (i) Chairman of the Department concerned - (Convener)
   (ii) One senior teacher of the Department in each broad area of specialization (to be appointed by the BOS).
   (iii) Examiner(s) concerned.

The Result Moderation Committee will examine the result of each theory course and in case of an abnormal situation; it may take suitable corrective measures in consultation with the examiner(s). The examiner(s) will place the evaluated answer scripts along with the brief solution and marking scheme before the Committee. In case of difference of opinion among the members of the Committee, the majority decision will prevail, in which the examiner(s) will not participate.

**10. Degree Requirement**

(a) A student who earns 72 credits and fulfills such other conditions as may be mentioned in the curriculum will be awarded the degree of Master of Technology. He/she must also pay all University dues as per rules. Moreover, there should be no case of indiscipline pending against him/her.

(b) If a student earns more credits than the minimum required for the award of degree, his/her CPI will be calculated by considering the best grades subject to fulfilling the criteria of required credits as specified in the curriculum.

**11. Name Removal from the Rolls of the University and Mercy Appeal 11.1**

**Name Removal**

The earned credits (EC) of every student will be checked at the end of even number of semesters and if the total credits earned by the student are less than the minimum required as given below, his/her admission to the M. Tech. program will be cancelled and his/her name will be removed from the rolls of the University.

| Check Point (No. of semesters after admission) | Minimum EC requirement |
|---|---|
| 2 semesters | 0 |
| 4 semesters | 25 |
| 6 semesters | 50 |
| 8 semesters | 72 |

For part-time student:

| Check Point (No. of semesters after admission) | Minimum EC requirement |
|---|---|
| 2 semesters | 0 |
| 4 semesters | 15 |
| 6 semesters | 30 |
| 8 semesters | 52 |
| 10 semesters | 72 |

**11.2 Mercy Appeal**

If the name of a student is removed from the rolls of the University as per provisions of clause 11.1 of these ordinances, he/she may appeal to the Vice-Chancellor stating the reasons for not being able to earn the required credits and the Vice-Chancellor, if he is satisfied with the reasons, may allow the continuation of admission of the student only once during the tenure of the program, extending the total duration of the program by one year, at the maximum, if required. Under any circumstances no full-time student will be allowed to complete the program after the lapse of 10 semesters after admission; and no part-time student will be allowed to complete the program after the lapse of 12 semesters after admission.

**12. Result**

(a) If a student passes all the examinations and fulfills all the requirements for the award of degree his/her result will be shown as “Pass”.

(b) The Division awarded to “Pass” students will be based on CPI as given below:

**First Division (Honours)** $\quad$ **CPI ≥ 8.5**

**First Division** $\quad$ **6.5 ≤ CPI ≤ 8.5**

**Second Division** $\quad$ **CPI < 6.5**

There shall be no formula for conversion of CPI or SPI into equivalent percentage of marks during the program. However, once the program is completed by a student and he/she is graduated, his/her final CPI will be converted into equivalent percentage of marks by the following formula:

$$y = (20x^3 - 380x^2 + 2725x - 1690)/84$$

where y is the percentage of marks and x is the CPI.

(c) If a student earns more credits than the minimum required as given in the table in clause 11.1 before fulfilling the degree requirements, his/her result will be shown as "Continued".

(d) If the name of a student is removed from the rolls of the University as per provisions of clause 11.1 of these ordinances his/her result will be shown as "Name Removed".

(e) Ranks/Positions will be determined at the end of even semesters. Only those full-time students who fulfill the following conditions will be eligible for ranks/positions:

(i) They do not have any break in their studies;
(ii) They have passed every scheduled course in first attempt;
(iii) They have passed every course on time as per the curriculum;
(iv) They have earned credits as per the schedule given in the curriculum;
(v) They have not improved grade in any course after passing the course;
(vi) They have obtained a "Pass" result in four semesters by a date determined as 14 days after opening of the university after the summer vacation.

The students who violate any of the above conditions will not be awarded any rank/position. The ranks/positions will be determined on the basis of CPI.

(f) Students who obtain a "Pass" result in a Calendar year shall be awarded Degree for that year.

13. **Transitory Ordinance**

Candidates admitted prior to the implementation of these Ordinances shall be governed by the Ordinances (Academic) under which they were admitted. Students who fail in the courses that are no more offered in these new ordinances and new curriculum will be allowed to pass the alternative courses, and in case there are no alternative courses, the old courses may be offered. For such candidates, any marks obtained earlier shall not be taken into account for passing the course(s) and they will have to obtain marks in all components of evaluation afresh. A student admitted previously may apply to the Dean through the Chairman concerned, to be governed by these ordinances. Such cases may be allowed on a case by case basis.

# REGULATIONS TO CHAPTER XXXVI (E) OF ORDINANCES (ACADEMIC)

**M. Tech. Degree Program**

**1. Explanations**

**1.1 Course Number**

Every course has a course number consisting of 5 characters (minimum) and 6 characters (maximum). The first two characters are alphabets indicating the department that offers or coordinates the course; the third character is a numerical digit indicating the year of offering the course in the program; the fourth character is a numerical digit indicating the type of course; the fifth character is a numerical digit that does not indicate any particular thing; and the sixth character is optional.

(a) The first two alpha characters will mean the following:

AC = Department of Applied Chemistry
AM = Department of Applied Mathematics
AP = Department of Applied Physics
AR = Department of Architecture
CE = Department of Civil Engineering
CH = Department of Chemical Engineering
CO = Department of Computer Engineering
EE = Department of Electrical Engineering
EL = Department of Electronics Engineering
ME = Department of Mechanical Engineering
PK = Department of Petroleum Studies
EZ = Departments external to Z.H. College of Engineering & Technology

(b) The third character will be 6 for First Year and 7 for Second Year of the M. Tech. program.
(c) The fourth character will be interpreted as follows:

1-7 = Theory courses
8 = Courses such as Seminar, Colloquium, Field work, etc.
9 = Laboratory/Practical courses, Projects, and Dissertation.

**1.2 Faculty Number**

Every student has a Faculty number consisting of 9 characters. The first two characters are numerical digits indicating the year of admission; the third and fourth characters are alphabets indicating the branch of the M. Tech. program; the fifth character is an alphabet indicating the specialization; the sixth character is always "M" indicating M. Tech. program; the seventh, eighth and ninth characters are numerical digits that are for identifying a student of a particular batch.

(c) The first two characters will be the right most two digits of the year of admission. Thus students admitted in 2011 will have the first two characters as 11.

(d) The third and fourth characters will be interpreted as follows:

AP = Applied Physics
CE = Civil Engineering
EE = Electrical Engineering
KE = Chemical Engineering
LE = Electronics Engineering
ME = Mechanical Engineering
PE = Computer Engineering
PK = Petrochemical Engineering

**1.3 Marks**

(a) The combined total marks obtained by a student in the course work and the mid-semester examination will be called Sessional Marks.

(b) The marks obtained by a student in the end-semester examination will be called Examination Marks.

**2. Conduct of Teaching**

**2.1 Course In-charge**

Every course will be taught by one or more teachers. The BOS of the concerned department will allocate the teaching load to the teacher(s) and will also designate a course in-charge for each course. If more than one department is involved in the teaching of the course, the course in-charge will be from the coordinating department. The course in-charge will coordinate all the work related to attendance, course work, examination and evaluation. It is necessary that the students are informed about the course in-charge so that they may contact him/her about any problems regarding the course.

**2.2 Display of Attendance, Marks etc.**

It is essential that the attendance should be displayed to the students twice in a semester, once in the middle and then at the end of a semester by the teacher(s) concerned. The mid-semester marks should be displayed to students normally within 15 days of the examination. The total Sessional marks should be displayed to the students before the beginning of the end-semester examinations. The course in-charge will ensure that the teachers associated with the course make such displays and, in case of complaints from the students in this regard, shall inform the Chairman of the concerned department about the problem.

**2.3 Offering Courses**

Courses will be offered by the department concerned as per the schedule given in the relevant Curriculum. Elective courses will be offered depending on the availability of the staff and other facilities and therefore any particular elective course may not be offered even though it may exist in the list of possible elective courses. Departments may also offer a course in both the semesters even though it may be shown in particular semesters.

**2.4 Syllabus**

Each course will have a syllabus which will be distributed to the students. The teacher(s) concerned should ensure that some portion, beyond the syllabus, should also be covered in the class.

**3. Correction of Errors**

In case any error is detected in the marks recorded on the award list, the examiner(s) concerned shall make a request to correct the mistake to the Dean, Faculty of Engg. & Tech. through the Chairman of the concerned department, and shall attach relevant documentary evidence. A committee consisting of the following members shall take suitable remedial measures depending upon the merit of the case.

1. Dean, Faculty of Engg. & Tech. (Chairman)
2. Principal, ZH College of Engg. & Tech.
3. Chairman of the concerned department.
4. One senior member of the Faculty, not belonging to the concerned department, to be nominated by the Dean.
5. Chief Tabulator, M. Tech. Program.

**5. Examinations**

**4.1 Mid-Semester Examination**

Mid-semester examination(s) of each course will be of one hour duration and will be conducted as per norms and schedule notified by the office of the Dean in each semester.

**4.2 End-Semester Examination**

End-semester examination(s) of each theory course shall be of three hours duration and will be conducted as per norms and schedule notified by the Controller of Examination of the University on the advice of the Dean. The end-semester examinations of laboratory/practical courses, and other courses such as seminar, colloquium, field work, project, dissertation etc. shall be conducted as notified by the Dean/Chairman concerned.

**4.3 Make-up Test**

Students who miss the Mid-Semester Examination in a course due to illness or some other extra-ordinary compelling situation may contact the teacher(s) concerned of the course with the request to conduct a make-up test. The teacher(s) shall follow the guidelines in this regard approved by the Faculty from time to time. There shall be no make-up test/examination for end-semester examinations.

# PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

1. To produce Electronics Engineering graduates for intricate technology challenges for betterment of society.
2. To impart research skills amongst the graduates with professional and ethical attitude.
3. To meet educational and industrial needs through effective communication of knowledge.

# PROGRAM OUTCOMES (POS)

a. To understand and integrate existing and new acquired knowledge in the discipline for future enrichment.

b. Ability of creative thinking, critical analysis and decision making for productive research and development.

c. Devise feasible and optimal solutions to the problems in the area of expertise, amenable to society and environment.

d. To conduct literature surveys and contribute in emerging areas through collaborative and multidisciplinary research.

e. Understanding of tools and techniques, and their usage in analysis and design.

f. Ability to write reports and communicate through effective presentations.

g. To improve capability for solving engineering problems.

h. Understanding of the professional and ethical responsibilities.

i. Ability of independent and reflective learning.

# M. TECH (ELECTRONIC CIRCUITS AND SYSTEM DESIGN) COURSE STRUCTURE

**First Semester**

| S.No. | Course No. | Course Title | Periods/week | | | Credit | Course Work Marks | Mid-Sem. Exam Marks | End Sem Univ. Exam Marks |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | P | G | | | | |
| 1 | AM-651 | Advanced Mathematics | 3 | 0 | 1 | 4 | 15 | 25 | 60 |
| 2 | EL-681 | Computer Networks | 3 | 0 | 1 | 4 | 15 | 25 | 60 |
| 3 | EL-611 | Electronic Circuits | 3 | 0 | 1 | 4 | 15 | 25 | 60 |
| 4 | EL-621 | VLSI Design | 3 | 0 | 1 | 4 | 15 | 25 | 60 |
| 5 | | Elective -I | 3 | 0 | 1 | 4 | 15 | 25 | 60 |
| 6 | | Elective -II | 3 | 0 | 1 | 4 | 15 | 25 | 60 |
| | | **Total** | **18** | **0** | **6** | **24** | | | |

**Second Semester**

| S.No. | Course No. | Course Title | Periods/week | | | Credit | Course Work Marks | Mid-Sem. Exam Marks | End Sem Univ. Exam Marks |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | | | | |
| 1 | EL-641 | Advanced Microprocessor Systems & Design | 3 | 0 | 1 | 4 | 15 | 25 | 60 |
| 2 | EL-622 | Adv. Analog IC Design | 3 | 0 | 1 | 4 | 15 | 25 | 60 |
| 3 | | Elective -III | 3 | 0 | 1 | 4 | 15 | 25 | 60 |
| 4 | | Elective -IV | 3 | 0 | 1 | 4 | 15 | 25 | 60 |
| 5 | | Elective -V | 3 | 0 | 1 | 4 | 15 | 25 | 60 |
| 6 | EL-600 | Lab/Project/Design | 0 | 4 | 0 | 4 | 60 | - | 40 |
| | | **Total** | **15** | **4** | **5** | **24** | | | |

## Third Semester

| S.No. | Course No. | Course Title | Periods/week | | | Credit | Course Work Marks | Mid-Sem. Exam Marks | End Sem Univ. Exam Marks |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | P | G | | | | |
| 1 | | Elective-VI | 3 | 0 | 1 | 4 | 15 | 25 | 60 |
| 2 | EL-780E | General Seminar | 0 | 0 | 2 | 2 | 60 | | 40 |
| 3 | EL-791E | Lab/Project | 0 | 3 | 0 | 3 | 60 | | 40 |
| 4 | EL-781E | Preliminary Dissertation Seminar | 0 | 0 | 3 | 3 | 60 | | 40 |
| | | **Total** | **3** | **3** | **6** | **12** | | | |

## Fourth Semester

| S.No. | Course No. | Course Title | Periods/week | | | Credit | Course Work Marks | Mid-Sem. Exam Marks | End Sem Univ. Exam Marks |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | P | G | | | | |
| 1 | EL-782E | Final Dissertation Seminar | 0 | 0 | 0 | 2 | 60 | | 40 |
| 2 | EL-798E | Dissertation | 0 | 0 | 3 | 10 | 60 | | 40 |
| | | **Total** | **0** | **0** | **3** | **12** | | | |

# LIST OF DEPARTMENTAL ELECTIVES

| | |
|---|---|
| EL 612 | Active & Monolithic Filters |
| EL 613 | Advanced Device Modelling |
| EL 618 | Current Mode Circuits and Applications |
| EL 623 | IC Processes & Fabrication |
| EL 626 | Digital System Design Using HDL |
| EL 631 | Advanced Electronic Instrumentation |
| EL 745 | Artificial Neural Network & Its Application |

# SYLLABI

| | | | |
|---|---|---|---|
| **Course Number and Title** | : | **AM-651, Advanced Mathematics** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | Nil | |
| Contact Hours (L-P-G) | : | 3-0-1 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Course Work (Home Assignments / Quizzes) | (15%) |
| | | Mid semester Examination (1 hour) | (25%) |
| | | End semester Examination (3 hour) | (60%) |

## Course Objectives

To learn vector spaces, statistical techniques, Bessel's functions, Legendre polynomials and Chebyshev polynomials.

## Course Outcomes

After completion of this course, students shall be able to:

1. Understand vector spaces, linear transformation and matrices.
2. Apply various statistical techniques for electronics engineering problems.
3. Use knowledge of Bessel's, Legendre functions and Chebyshev polynomials.

## Syllabus

Vector spaces, vector norms, inner products and orthogonality, linear transformations, unitary transformations: QR and SV decompositions, least squares and generalized inverses, similarity transformations.

Discrete Random Variables, conditional and bivariate distributions, mean square estimation, random numbers and their generation

Digital random processes, parameter estimation and hypothesis testing, fitting and prediction.

Bessel's functions of $1^{st}$& $2^{nd}$ kind, modified Bessel's functions, Kelvins functions, Legendre polynomials their integrals and derivatives, Chebyshev polynomials.

## Text Book(s)/Reference Book(s)


1. Ben Noble and Daniel, "Applied Linear Algebra", Prentice Hall International.
2. A. Papoulis, Probability, "Random Variables & Stochastic Processes", McGraw-Hill.
3. Ronald H. Walpole and R. H. Myers, "Probability and Statistics for Engineers and Scientists", Macmillan Publishing.
4. E. Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, Inc.

**Relationship of COs with POs:**

| COs | POs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i |
| 1 | X | X | | X | | | | | |
| 2 | X | X | | | | | | | |
| 3 | | | | | X | | X | | |

| | | | |
|---|---|---|---|
| **Course Number and Title** | : | **EL-600, Lab/Project/Design** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | Nil | |
| Contact Hours (L-P-G) | : | 0-4-0 | |
| Type of Course | : | Practical | |
| Course Assessment | : | Course Work | (60%) |
| | | End semester Examination | (40%) |

## Course Objectives

To design and verify the digital and analog circuits from a given specification at the transistor level in deep submicron using Cadence tools.

## Course Outcomes

After completion of this course, students shall be able to:

1. Learn the Cadence's Design Automation tools.
2. Use these tools to design digital/analog circuits.
3. Use these tools to draw layouts.
4. Present works in form of report.

## List of Experiments/Projects

1. Introduction to Cadence tools for Analog/Digital circuit Design.
2. Design of CMOS inverter along with its layout using Cadence tools
3. Design of basic logic gates and full adder with their layout using Cadence tools.
4. Design of a CMOS current mirror using Cadence tools.
5. Design of CMOS inverting amplifier with layout using Cadence tools.
6. Design of a CMOS differential amplifier with layout using Cadence tools.
7. Design of a CMOS Opamp for a given specification using Cadence tools.
8. One small project

**Relationship of COs with POs**

| COs | POs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i |
| 1 | X | | | | X | | X | | X |
| 2 | X | X | X | | X | X | X | X | X |
| 3 | X | X | | | X | | X | | X |
| 4 | | | | | X | | | X | X |

| | | | |
|---|---|---|---|
| **Course Number and Title** | : | **EL-611, Electronic Circuits** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | Nil | |
| Contact Hours (L-P-G) | : | 3-0-1 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Course Work (Home Assignments / Quizzes) | (15%) |
| | | Mid semester Examination (1 hour) | (25%) |
| | | End semester Examination (3 hour) | (60%) |

## Course Objectives

To gain an understanding of the analysis, design and applications of basic building blocks of electronic devices.

## Course Outcomes

After completion of this course, students shall be able to:

1. Understand advance electronic circuits.
2. Use active building blocks for various applications.
3. Perform critical analysis of anolog circuits.

## Syllabus

Review of Biasing Techniques and their Applications: Dependence of Output Currents on β; Output Impedance and Voltage

Specialized op-Amps: Comparators, Single Supply Op-amps, Norton Amplifiers; CFAs and Wideband Amplifiers and Wide banding Techniques

Wave Shaping Circuits: Function Generator Circuits; Triangular to Sinusoidal Converters; Multifunction Oscillators.

Multipliers/Dividers; Electronic/Digital Tuning of Oscillators and Filters

PLLs: Basic Principle, Analysis and Applications; Frequency Synthesizers, High Power Amplifiers and Modulators.

## Text Book(s)/Reference Book(s)


1. J.R. Smith, Modern Communication Circuits, TATA McGraw Hill, Edition 2003.
2. J.M. Jacob, Applications and Design with Analog ICs, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
3. Behzad Razavi, Design of Analog CMOS Integrated Circuits, McGraw Hill, New Delhi, 2001.

**Relationship of COs with POs:**

| COs | POs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i |
| 1 | X | X | | | | | | | |
| 2 | X | | X | | | | X | | |
| 3 | X | X | | | | | X | | |

| | | | |
|---|---|---|---|
| **Course Number and Title** | : | **EL-612, Active Monolithic Filters** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Elective | |
| Pre-requisite(s) | : | Electronic Circuits | |
| Contact Hours (L-P-G) | : | 3-0-1 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Course Work (Home Assignments / Quizzes) | (15%) |
| | | Mid semester Examination (1 hour) | (25%) |
| | | End semester Examination (3 hour) | (60%) |

**Course Objectives**

To provide students the knowledge of analysis, design of analog circuits for monolithic IC implementation.

**Course Outcomes**

After completion of this course, students shall be able to:

1. Understand and apply the concepts of filter theory.
2. Perform critical analysis of active filters.
3. Design current mode filters suited for IC integration.

**Syllabus**

Continuous-time Filters: Transconductance-C filters, Cascade design, Element simulation Method, Operational simulation method, Effects of OTA non-idealities, tuning procedures.

Switched Capacitor Filters: Introduction, The effects of parasitics and parasitic insensitive building blocks, Biquad building blocks and cascaded design, Ladder simulations, Observations and limits.

Current-Mode Filters: Current conveyors, Current mode building blocks, Biquadratic and higher order load insensitive filter realizations, Performance studies with device non-idealities.

**Text Book(s)/Reference Book(s)**


1. C. Toumazou, F.J. Lidgey and D.G. Haigh, "Analogue IC Design: The Current-Mode Approach", Peter Peregrinus Ltd., London, 1990.
2. R. Schauman, M.S. Ghausi, and K.R. Laker, "Design of Analog Filters: Active-RC and Switched Capacitor", Prentice Hall, Englewood Cliffs, New Jersey, 1990.
3. Y. Sun, "Circuit Devices & Systems, Design of High Frequency Integrated Analogue Filters", IEE Publishing, 2002.

**Relationship of COs with POs**

| COs | POs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i |
| 1 | X | X | | | | | | | |
| 2 | | X | | | X | | X | | |
| 3 | X | X | X | | | | X | | X |

| | | |
|---|---|---|
| **Course Number and Title** | : | **EL-618, Current Mode Circuits & Applications** |
| Credits | : | 4 |
| Course Category | : | Departmental Elective |
| Pre-requisite(s) | : | Electronic Circuits |
| Contact Hours (L-P-G) | : | 3-0-1 |
| Type of Course | : | Theory |
| Course Assessment | : | Course Work (Home Assignments / Quizzes) (15%)<br>Mid semester Examination (1 hour) (25%)<br>End semester Examination (3 hour) (60%) |

## Course Objectives

To gain an understanding of the analysis, design and applications of current-mode circuits suited for emerging technology challenges.

## Course Outcomes

After completion of this course, students shall be able to:

1. Acquire knowledge of current-mode circuits.
2. Model and critically analyse current-mode circuits.
3. Design current-mode circuits with emphasis on IC realization.

## Syllabus

Current Mode Devices: Current Mode; Current Mode Active Elements; Advantages Over Voltage Mode; Design of Current Conveyors; Current Controlled Conveyors; Current Feedback Amplifiers; Differential Voltage Current Conveyors.

Current Mode Circuits: CCII Based Circuits: Advantages and Limitations; Translinear-C Circuits: Linear and Nonlinear Applications; Non-idealities in Current Mode Circuits.

Interfaces and Applications: Analog Interface Circuits for VLSI; Current Mode A/D and D/A Converters; Current Mode Neural Building Blocks.

## Text Book(s)/Reference Book(s)


1. C. Toumazou, F. J. Lidgey and D. H. Haigh, Analogue IC Design: the current mode approach, IEE Press, 1998.
2. F. Yuan, CMOS Current mode circuits for data communication, Springer, 2006.
3. P. V. Anand Mohan, Current mode VLSI Analog filters, Springer, 2004.

**Relationship of COs with POs**

| COs | POs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i |
| 1 | X | | | | | | | | |
| 2 | X | X | | | | | X | | X |
| 3 | X | | X | | X | | X | X | X |

| | | | |
|---|---|---|---|
| **Course Number and Title** | : | **EL-621, VLSI Design** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | Nil | |
| Contact Hours (L-P-G) | : | 3-0-1 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Course Work (Home Assignments / Quizzes) | (15%) |
| | | Mid semester Examination (1 hour) | (25%) |
| | | End semester Examination (3 hour) | (60%) |

## Course Objectives

To gain an understanding towards design of actual VLSI sub systems from high level specifications and culminates in a course which involves the modelling, synthesis and physical design of a complex chip.

## Course Outcomes

After completion of this course, students shall be able to:

1. Knowledge of VLSI design methodologies.
2. To understand latest trends in semiconductor technology.
3. To understand principles of CMOS testing.
4. Ability to design VLSI circuits with feasibility in IC form.

## Syllabus

Design Methods: Review of design strategies and CMOS chip design options, Design methods- Behavioral and RTL synthesis, placement, routing, layout synthesis. Design capture tools, design verification tools.

CMOS Testing Test principles, design strategies for test, chip level and system level test techniques.

CMOS Subsystem design: Data path operators- addition/subtraction, counters, multiplication, Memory elements, Finite state machines and controlled logic implementation.

## Text Book(s)/Reference Book(s)


1. Neil Weste and Kamran Esharghian “Principles of CMOS VLSI Design” Pearson Education, 2001.
2. Jan. M. Rabaey “Digital Integrated Circuits: A Design Perspective “Prentice Hall, *2005.*

**Relationship of COs with POs**

| COs | POs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i |
| CO1 | X | | | | | | | | |
| CO2 | X | | X | | | | | | |
| CO3 | X | | X | | X | | X | X | |
| CO4 | | X | X | | X | | X | X | X |

| | | |
|---|---|---|
| **Course Number and Title** | : | **EL-622, Advanced Analog IC Design** |
| Credits | : | 4 |
| Course Category | : | Departmental Core |
| Pre-requisite(s) | : | Electronic Circuits |
| Contact Hours (L-P-G) | : | 3-0-1 |
| Type of Course | : | Theory |
| Course Assessment | : | Course Work (Home Assignments / Quizzes) (15%)<br>Mid semester Examination (1 hour) (25%)<br>End semester Examination (3 hour) (60%) |

## Course Objectives

To learn the design of basic analog building blocks from a given specification at the transistor level.

## Course Outcomes

After completion of this course, students shall be able to:

1. Study advance MOSFET device models
2. Analyse a given CMOS analog circuit
3. Design analog circuits at the transistor level to meet given specifications.

## Syllabus

Introduction to Analog Design, MOS Device Physics, Design of CMOS Based Single Stage and Differential Amplifiers, Passive and Active Current Mirrors, Frequency Response of Amplifiers, Noise, Design of Single and Two Stage MOS Operational Amplifiers, Stability and Frequency Compensation, Low Power Analog Design, Bandgap References, Introduction to Switched Capacitor Circuits, Analog Layout Considerations and Packaging Issues.

## Text Book(s)/Reference Book(s)


1. Behzad Razavi, Design of Analog CMOS Integrated Circuits, Tata McGraw Hill, 2002.
2. P.E. Allen and D.R. Holberg, CMOS Analog Circuit Design, Oxford University Press, 2011.

**Relationship of COs with POs**

| COs | POs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i |
| CO1 | X | X | | | | | | | |
| CO2 | X | X | | | X | | | | |
| CO3 | X | X | X | | X | | X | X | X |

| | | |
|---|---|---|
| **Course Number and Title** | : | **EL-623, IC Process & Fabrication** |
| Credits | : | 4 |
| Course Category | : | Departmental Elective |
| Pre-requisite(s) | : | Nil |
| Contact Hours (L-P-G) | : | 3-0-1 |
| Type of Course | : | Theory |
| Course Assessment | : | Course Work (Home Assignments / Quizzes) (15%)<br>Mid semester Examination (1 hour) (25%)<br>End semester Examination (3 hour) (60%) |

## Course Objectives

The aim of the course is to provide students with a glimpse into the semiconductor industry that has brought about the technology revolution. Because of the interdisciplinary nature of the subject, its content includes concepts from electronics engineering, chemistry and material science.

## Course Outcomes

After completion of this course, students shall be able to:

1. Understand clean room technology.
2. Acquire the knowledge of production of single crystal wafer and their cleaning.
3. Understand the advanced processes used in monolithic IC fabrication.
4. Develop in-sight into complete fabrication sequence for MOS and Bi-CMOS processes.

## Syllabus

Cleanroom Technology: Cleanroom: classification, design concept, installation operations and automation.
Wafer-Cleaning Technology: Basic concept of Wafer cleaning, wet-cleaning and dry cleaning technology.
Film Deposition: Conventional Si Epitaxy, low temperature Epitaxy, Molecular beam Epitaxy, LPCVD, APCVD and Plasmal assisted deposition.
Process Integration and Simulation: CMOS technology, Bipolar technology, BiCMOS technology and MOS memory technology, Process simulation.

## Text Book(s)/Reference Book(s)


1. Campbell, "The Science and Engineering of Microelectronic Fabrication", Oxford University Press.
2. S.M. Sze, "VLSI Technology", McGraw Hill.

**Relationship of COs with POs**

| COs | POs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i |
| 1 | X | | | | X | | | | |
| 2 | X | | | | | | | | |
| 3 | | X | | | X | | | | |
| 4 | X | X | X | | | | X | X | |

| | | | |
|---|---|---|---|
| **Course Number and Title** | **:** | **EL-626, Digital System Design using HDL** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Elective | |
| Pre-requisite(s) | : | Nil | |
| Contact Hours (L-P-G) | : | 3-0-1 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Course Work (Home Assignments / Quizzes) | (15%) |
| | | Mid semester Examination (1 hour) | (25%) |
| | | End semester Examination (3 hour) | (60%) |

## Course Objectives

To become proficient in the design of digital systems to satisfy a given specification in deep submicron.

## Course Outcomes

After completion of this course, students shall be able to:

1. Understand the design flow of digital systems using design automation tool.
2. Use Verilog HDL for modelling of digital systems at a higher level.
3. Design digital systems from a given specifications in terms of area, speed and power consumption.
4. Implement the design in IC technologies like ASICs and FPGA.

## Syllabus

Review of concept of Digital System Design. Hardware Description language. VHDL and Verilog Language Organization. HDL - Combinational System. Structural Modelling in VHDL and Verilog - Component and signal declaration. Component instantiation statements, hierarchical structure. Data Flow Modelling. HDL Sequential System Describing synchronous behaviour. Algorithmic Modelling.

## Text Book(s)/Reference Book(s)


1. Charles H Roth Jr. "Digital System Design Using HDL", Thomson Learning, 2007
2. Allen. M. Dewey, "Analysis and Design of Digital System with VHDL", IBM Corporation, PWS Publishing Company 1997.
3. W. I. Fletcher, "An Engineering Approach to Digital Design", PHI 2012.

**Relationships of COs with POs**

| COs | POs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i |
| 1 | X | X | | | X | | | | |
| 2 | X | X | X | | X | | X | X | |
| 3 | | X | X | | X | | X | X | X |
| 4 | | X | X | | X | | X | X | X |

| | | |
|---|---|---|
| **Course Number and Title** | : | **EL-631, Advanced Electronic Instrumentation** |
| Credits | : | 4 |
| Course Category | : | Departmental Elective |
| Pre-requisite(s) | : | Nil |
| Contact Hours (L-P-G) | : | 3-0-1 |
| Type of Course | : | Theory |
| Course Assessment | : | Course Work (Home Assignments / Quizzes) (15%)<br>Mid semester Examination (1 hour) (25%)<br>End semester Examination (3 hour) (60%) |

## Course Objectives

Study of advance techniques for the measurement of impedances, transducers based upon capacitive, fiber-optic and ultrasonic techniques and interfacing of transducers with computers.

## Course Outcomes

After completion of this course, students shall be able to:

1. Understand advanced measurement techniques.
2. Gain in-depth knowledge of capacitive, fiber-optic and ultrasonic transducers.
3. Apply impedance measurement techniques for bio-medical diagnostics.
4. Design compensating and interfacing circuits for analog transducers.

## Syllabus

Advanced techniques for the measurement of different types of impedances and their applications in the field of instrumentation.

Review of the transformer ratio-arm bridges. Active bridge techniques for the measurement of simple and in-circuit resistance and impedances. Applications of impedances in the measurement of non-electrical quantities and biomedical instrumentation.

Precision Grade transducers: Precision type transducers based upon capacitive, fiber-optic and ultrasonic techniques for displacement, temperature, pressure, speed and flow measurement.

Different compensating & interfacing techniques and their applications in the field of instrumentation. Compensation for leakage impedances, compensation of ambient temperature of thermocouples, interfacing of analog transducers with computers especially for temperature and pressure.

**Text Book(s)/Reference Book(s)**


1. E. O. Doebelin, “Measurement System Applications and Design” Fourth Edition, McGraw Hill Publishing Co.
2. Oliver and Cage, “Electronic Measurement and Instrumentation”, McGraw Hill.
3. D. V. S. Murty, “Transducers and Instrumentation”, second edition, PHI.
4. David A. Bell, “Electronic Instrumentation and Measurements, second edition, Oxford.
5. M. M. S. Anand, “Electronic Instrumentation and Instrumentation Technology, PHI. 6. S. Ananthi, “A textbook of Medical Instruments”, New Age International (P) Limited.


**Relationship of COs with POs**

| **COs** | **POs** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i |
| 1 | X | X | | X | | | | | |
| 2 | X | X | | X | | | X | | X |
| 3 | X | X | | X | | | X | | |
| 4 | | | X | | | | X | X | X |

| | | |
|---|---|---|
| **Course Number and Title** | **:** | **EL-641, Advanced Microprocessor Systems & Design** |
| Credits | : | 4 |
| Course Category | : | Departmental Core |
| Pre-requisite(s) | : | Nil |
| Contact Hours (L-P-G) | : | 3-0-1 |
| Type of Course | : | Theory |
| Course Assessment | : | Course Work (Home Assignments / Quizzes) (15%)<br>Mid semester Examination (1 hour) (25%)<br>End semester Examination (3 hour) (60%) |

## Course Objectives

Study of architecture of different microcontroller's and advance microprocessors, their interfacing, programming, design and recent advances in this area.

## Course Outcomes

After completion of this course, students shall be able to:

1. Differentiate between various microprocessors and micro-controllers.
2. Understand the architecture and programming models of microprocessors and micro-controllers.
3. Understand the instruction sets of microprocessors and micro-controllers.
4. Apply the knowledge gained to write programs for interfacing the processors with peripherals.

## Syllabus

Introduction to Single chip Micro-Computers, Architecture of 8048 and 8051 microcomputer chips, Examples of Micro-computer based design, Architecture of 16 bit microprocessors-Special emphasis on Intels 8086/8088 and Motorola's 68000 microprocessors, Coprocessors 8087 and 8089, Introduction to 32 bit and 64 bit Microprocessors and recent advances in Microprocessor architectures.

## Text Book(s)/Reference Book(s)


1. Microcomputer System: The 8086/8088 family, Y. C. Liu, and G. A. Gibson, Prentice Hall.
2. Introduction to Microprocessor, A. P. Mathur, , 3rd edition, McGraw Hill
3. The 68000 Microprocessor, Architecture, programming and applications, M. A. Miller, UBS
4. Digital Systems, From glass to Microprocessor, S. K. Bose, PHI

5. Advanced Microprocessors and Peripherals, A. K. Ray and K. M. Bhurachandi, TATA McGraw Hill.
6. The Intel Microprocessors 8086/80186, 80286, 80386, 80486, Pentium and Pentium pro Processors, Architecture, programming and interfacing. B. B. Brey, 4th editon PHI.

**Relationship of COs with POs**

| COs | POs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i |
| 1 | X | X | | | | | | | |
| 2 | X | X | X | | X | | | | X |
| 3 | X | X | X | | X | | | | X |
| 4 | | | X | | X | | X | | X |

| | | |
|---|---|---|
| **Course Number and Title** | : | **EL-681, Computer Networks** |
| Credits | : | 4 |
| Course Category | : | Departmental Core |
| Pre-requisite(s) | : | Nil |
| Contact Hours (L-P-G) | : | 3-0-1 |
| Type of Course | : | Theory |
| Course Assessment | : | Course Work (Home Assignments / Quizzes) (15%)<br>Mid semester Examination (1 hour) (25%)<br>End semester Examination (3 hour) (60%) |

## Course Objectives

To gain an understanding of the concepts in computer networking. Familiarize students with the basic network protocols and security issues.

## Course Outcomes

After completion of this course, students shall be able to:

1. Identify different types of network devices and their functions.
2. Apply queuing model to computer network.
3. Analyze the functions of TCP/IP layers.
4. Design different types of computer network.

## Syllabus

Overview of OSI; Data link control and its Protocol; LANs and their types; High speed and Bridged LANs; ISDN; X.25 and Frame Relay; ATM; SONET/SDH; Routing; Upper OSI layers; Internetworking concepts, architecture, and protocols; IP addresses and datagram forwarding; TCP/IP protocol suite; Data compression for modern networks; Network security; Home and small office networks; New evolving networks.

## Text Book(s)/Reference Book(s)


1. Fred Halsall, "Data Communications, Computer Networks and Open Systems", Addison Wesley, 1996.
2. B.A. Forouzan, "Data Communications and Networking", Tata McGraw Hill, 2000.
3. Douglas E. Comer, "Computer Networks and Internets", Prentice Hall, 1997.
4. M.A. Gallo and W.M. Hancock, "Computer Communications and Networking Technologies", Thomson, 2002.
5. Keshav, "An Engineering Approach to Computer Networking", Pearson Education.
6. Andrew S. Tanenbaum, "Computer Networks", Pearson Education, 2003.

**Web Resources**

1. https://www.coursera.org/
2. http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-263j-data-communicationnetworks-fall-2002/
3. http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-829-computer-networks-fall-2002/
4. http://nptel.iitm.ac.in/courses/IIT-MADRAS/Computer_Networks/index.php

**Relationship of COs with POs**

| COs | POs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i |
| 1 | X | X | | | | | | | |
| 2 | | X | | | | | X | | |
| 3 | X | X | | | X | | | | X |
| 4 | X | X | X | | X | | | | X |

| | | | |
|---|---|---|---|
| **Course Number and Title** | : | **EL-727, Low Power VLSI Design** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Elective | |
| Pre-requisite(s) | : | VLSI Design | |
| Contact Hours (L-P-G) | : | 3-0-1 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Course Work (Home Assignments / Quizzes) | (15%) |
| | | Mid semester Examination (1 hour) | (25%) |
| | | End semester Examination (3 hour) | (60%) |

## Course Objectives

To understand the concepts of power estimation and optimization techniques for low power VLSI design at different levels.

## Course Outcomes

After completion of this course, students shall be able to:

1. Understand low-power design techniques.
2. Apply low power techniques for the design of digital circuits/systems.
3. Design circuits for ultra low power systems.

## Syllabus

Introduction to low power VLSI design, Sources of power consumption, Approaches for low power design: voltage scaling, minimising the switched capacitance, Low power VLSI design limits, Low voltage technologies, Circuit styles for low power consumption, Glitching power reduction, Low power Bus architectures, Adiabatic or energy recovery logic, Low power SRAM Architectures, Software design for low power.

## Text Book(s)/Reference Book(s)


1. P. Chandrakasan & R. W. Brodersen, “Low power VLSI design”, Kluwer Academic Publishers, Fifth printing, 2002.
2. K. Roy & S. C. Prasad, “Low power CMOS VLSI circuit design”, Wiley Interscience Publication, 2000.
3. J. Rabaey, “Low power design essentials”, Springer, 2009.

**Relationship of COs with POs**

| COs | POs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i |
| 1 | X | | | | | | | | |
| 2 | X | X | X | | X | | X | X | |
| 3 | X | X | X | | X | | X | | X |

| | | |
|---|---|---|
| **Course Number and Title** | : | **EL-745, Artificial Neural Network & its Applications** |
| Credits | : | 4 |
| Course Category | : | Departmental Elective |
| Pre-requisite(s) | : | Nil |
| Contact Hours (L-P-G) | : | 3-0-1 |
| Type of Course | : | Theory |
| Course Assessment | : | Course Work (Home Assignments / Quizzes) (15%)<br>Mid semester Examination (1 hour) (25%)<br>End semester Examination (3 hour) (60%) |

**Course Objectives**

To gain an understanding of the analysis, design and applications of Artificial Neural Networks.

**Course Outcomes**

After completion of this course, students shall be able to:

1. Understand the concepts Artificial Neural Networks (ANN).
2. Develop knowledge of basic ANN architectures.
3. Analyse ANN systems.
4. Design specific ANN architectures for different problem domains.

**Syllabus**

Biological Foundations of Neural Networks; Early Neural models Network Architecture: Single Layer Perceptrons, Multi-Layer Perceptrons; Recurrent Networks Learning Processes: Supervised, Unsupervised; Design Issues: Pre-processing, Input and Output Encoding; Structure of Networks; Training, Validation and Testing the Prototype; Visualisation Methods: Clustering, Self-organising Maps, Sammon Maps; ANN Hardware and Implementation Concerns; Applications: Pattern Recognition, Pattern Analysis, Time Series Prediction; System Identification, Adaptive Control.

**Text Book(s)/Reference Book(s)**


1. Simon Haykin, *Neural Networks: A Comprehensive Foundation*, 2nd edition, Pearson Education Asia, 2001.
2. Robert J. Schalkoff, *Artificial Neural Networks*, McGraw Hill International edition, 1997.
3. D. L. Hudson and M. E. Cohen, *Neural Networks and Artificial Intelligence for Biomedical Engineering*, Prentice Hall of India, 2001.

**Relationship s of COs with POs**

| COs | POs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i |
| 1 | X | | | | | | | | |
| 2 | X | | | | | | | | X |
| 3 | | X | | | X | | | | |
| 4 | | | X | | X | | X | | |

| | | | |
|---|---|---|---|
| **Course Number and Title** | : | **EL-780E, General Seminar** | |
| Credits | : | 2 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | Nil | |
| Contact Hours (L-P-G) | : | 0-0-2 | |
| Type of Course | : | Seminar | |
| Course Assessment | : | Course Work | (60%) |
| | | End semester Examination | (40%) |

## Course Objectives

The aim of the course is to develop skills of surveying, compiling, understanding the literature on the topic(s) related to the Electronics and Communication Engineering and deliver effective presentation(s).

## Course Outcomes

After completion of this course, students shall be able to:

1. Carry out literature survey to understand the selected topics.
2. Prepare technical report and deliver effective presentation.
3. Develop ethical values and responsibilities.

## Relationship of COs with POs

| **COs** | **POs** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i |
| 1 | X | X | | X | | | | | |
| 2 | | | | | | X | | | |
| 3 | | | | | | | | X | |

| | | | |
|---|---|---|---|
| **Course Number and Title** | : | **EL-781E, Preliminary Dissertation Seminar** | |
| Credits | : | 3 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | Nil | |
| Contact Hours (L-P-G) | : | 0-0-3 | |
| Type of Course | : | Seminar | |
| Course Assessment | : | Course Work | (60%) |
| | | End semester Examination | (40%) |

## Course Objectives

To perform survey of literature based on the topic of dissertation, identify and analyze their shortcoming and initiate the proposal of new solutions. To write technical report and deliver effective presentations.

## Course Outcomes

After completion of this course, students shall be able to:

1. Perform in-depth literature survey.
2. Identify the research gaps and define research problem.
3. Use appropriate tools for solving the chosen problem.
4. Deliver effective presentations and prepare technical report.

## Relationship of COs with POs

| **COs** | **POs** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i |
| 1 | X | | | X | | | | | X |
| 2 | X | X | | X | | | | X | X |
| 3 | | X | X | | X | | X | | |
| 4 | | | | | | X | | X | |

| | | | |
|---|---|---|---|
| **Course Number and Title** | : | **EL-782E, Final Dissertation Seminar** | |
| Credits | : | 3 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | Nil | |
| Contact Hours (L-P-G) | : | 0-0-3 | |
| Type of Course | : | Seminar | |
| Course Assessment | : | Course Work | (60%) |
| | | End semester Examination | (40%) |

## Course Objectives

To perform topic related survey(s) so as to contribute towards knowledge through innovative research and communicate the developed idea(s).

## Course Outcomes

After completion of this course, students shall be able to:

1. Present the analysis of the dissertation problem.
2. Compare findings with existing solutions.
3. Draw inferences after evaluating the results.
4. Prepare and deliver effective presentations.

## Relationship of COs with POs

| **COs** | **POs** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i |
| 1 | X | X | | | X | X | X | X | |
| 2 | X | X | X | X | X | | X | X | X |
| 3 | | X | | | | | | X | X |
| 4 | | | | | X | | | X | X |

| | | | |
|---|---|---|---|
| **Course Number and Title** | : | **EL-791E, Lab/Project** | |
| Credits | : | 3 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | Nil | |
| Contact Hours (L-P-G) | : | 0-3-0 | |
| Type of Course | : | Practical | |
| Course Assessment | : | Course Work | (60%) |
| | | End semester Examination | (40%) |

## Course Objectives

To study and solve engineering problems through surveys, tools, and communicate the solutions.

## Course Outcomes

After completion of this course, students shall be able to:

1. Perform literature survey.
2. Verify and implement design ideas using appropriate tools.
3. Write technical report and communicate effectively through presentation.

## Relationship of COs with POs

| **COs** | **POs** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i |
| 1 | X | X | | X | | | | | X |
| 2 | | | X | | X | | X | | |
| 3 | | | | | | X | | | |

| | | | |
|---|---|---|---|
| **Course Number and Title** | : | **EL-798E, Dissertation** | |
| Credits | : | 10 | |
| Course Category | : | Departmental Core | |
| Pre-requisite(s) | : | Preliminary Dissertation Seminar, Final Dissertation Seminar | |
| Contact Hours (L-P-G) | : | 0-0-3 | |
| Type of Course | : | Dissertation | |
| Course Assessment | : | Course Work | (60%) |
| | | End semester Examination | (40%) |

## Course Objectives

To perform topic related survey(s) and contribute towards knowledge through innovative research and effectively communicate the contributions.

## Course Outcomes

After completion of this course, students shall be able to:

1. Independently identify research problem through extensive literature survey.
2. Analyse and compare the findings with state-of-art in the area.
3. Draw inferences and propose future research directions.
4. Present the work done through technical report and oral presentation.

## Relationship of COs with POs

| **COs** | **POs** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i |
| 1 | X | X | | X | | | | X | X |
| 2 | X | X | | X | X | | X | X | X |
| 3 | | X | X | | X | | X | X | X |
| 4 | | X | | | | X | | X | |

# M. TECH PROGRAM

## (COMMUNICATION & INFORMATION SYSTEMS)

# M. TECH. ELECTRONICS (COMMUNICATION & INFORMATION SYSTEM) COURSE STRUCTURE

| Course Code | Course Title | Total number of contact hours | | | | Credits |
|---|---|---|---|---|---|---|
| | | Lecture (L) | Tutorial (G) | Practical (P) | Total Hours | |
| **I Semester** | | | | | | |
| AM651 | Advanced Mathematics | 3 | 1 | 0 | 4 | 4 |
| EL681 | Computer Networks | 3 | 1 | 0 | 4 | 4 |
| EL611 | Electronic Circuits | 3 | 1 | 0 | 4 | 4 |
| EL651 | Information and Coding Theory | 3 | 1 | 0 | 4 | 4 |
| EL662 | Speech Processing (EL-I) | 3 | 1 | 0 | 4 | 4 |
| EL672 | Special Purpose Radars (EL-II) | 3 | 1 | 0 | 4 | 4 |
| **II Semester** | | | | | | |
| EL652 | Data Transmission Systems | 3 | 1 | 0 | 4 | 4 |
| EL661 | Advanced DSP | 3 | 1 | 0 | 4 | 4 |
| EL658 | Wireless Communication (EL-III) | 3 | 1 | 0 | 4 | 4 |
| EL663 | Image & Video Processing (EL-IV) | 3 | 1 | 0 | 4 | 4 |
| EL686 | Ad Hoc & Sensor Network (EL-V) | 3 | 1 | 0 | 4 | 4 |
| EL601 | Lab | 0 | 0 | 4 | 4 | 4 |
| **III Semester** | | | | | | |
| EL745 | ANN and Its Application (EL-VI) | 3 | 1 | 0 | 4 | 4 |
| EL780C | General Seminar | 0 | 2 | 0 | 2 | 2 |
| EL791C | Project | 0 | 0 | 3 | 3 | 3 |
| EL781C | Preliminary Dissertation Seminar | 0 | 3 | 0 | 3 | 3 |
| **IV Semester** | | | | | | |
| EL782C | Final Dissertation Seminar | 0 | 2 | 0 | 2 | 2 |
| EL798C | Dissertation | 0 | 3 | 0 | 10 | 10 |
| **Total** | | **36** | **22** | **7** | **72** | **72** |

# PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

PEO-1. To produce graduates with theoretical and practical knowledge of Communication Engineering and Technology for better employability and contribution to the development of industry as well as society.

PEO-2. To provide strong background required to pursue higher education or research in the field of communication and related interdisciplinary areas.

PEO-3. To develop professional and ethical outlook and effective communication skills.

# PROGRAM OUTCOMES (POS)

a. Ability to apply knowledge of sciences, mathematics and engineering principles to formulate and analyze communication engineering problems.
b. Ability to design and solve the engineering problems in the area of communication and information systems.
c. Usage of modern tools and techniques in solving the problems in contemporary areas.
d. Ability to identify and solve research problems in core and related multidisciplinary areas for rapidly changing technologically advancing society.
e. Development of effective written and oral communication skills.
f. Understanding of ethical, professional and societal responsibilities.
g. Ability to manage engineering projects and problems effectively under practical constraints.
h. Ability of independent thinking and lifelong learning.

# SYLLABI

# Department of Electronics Engineering

M. Tech. (Electronics Engineering)

*Specialization: Communication & Information Systems*

**2016-17**

| | | | |
|---|---|---|---|
| **Course Number and Title** | : | **AM-651 Advanced Mathematics** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Core (I semester) | |
| Pre-requisite(s) | : | Nil | |
| Contact Hours (L-T-P) | : | 3-1-0 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Home Assignments | (15%) |
| | | Midsem Examination (1 hour) | (25%) |
| | | Endsem Examination (3 hours) | (60%) |

## Course Objectives

Course Objectives To learn vector spaces, statistical techniques, Bessel's functions, Legendre polynomials and Chebyshev polynomials

## Course Outcomes

After completing this course the students should be able to:

1. Understand concepts of vector spaces, matrices and linear transformations
2. Apply various statistical techniques for solving practical problems
3. Use the knowledge of Bessel's functions, Legendre and Chebyshev polynomials for solving Electronics Engineering problems

## Syllabus

UNIT –I

Vector spaces, vector norms, inner products and orthogonality, linear Transformations, unitary Transformations: QR and SV decompositions, least squares and generalized inverses, similarity transformations.

UNIT –II

Discrete Random Variables, conditional and bivariate distributions, mean square estimation, random number s and their generation

UNIT –III

Digital random processes, parameter estimation and hypothesis testing, fitting and prediction

UNIT –IV

Bessel's functions of Ist & IInd kind, modified Bessel's functions, Kelvins functions, Legendre polynomials their integrals and derivatives, Chebyshev polynomials

.

**Reference Books**


1. Ben Noble and Daniel, Applied Linear Algebra, Prentice Hall International.
2. A. Papoulis, Probability, Random Variables & Stochastic Processes, Mc Graw-Hill.
3. Ronald H. Walpole and R. H. Myers, Probability and Statistics for Engineers and Scientists, Macmillan Publishing.
4. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, Inc.


**Relationship of COs with POs**

| COs | POs | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h |
| CO1 | H | | M | | | | | |
| CO2 | H | H | M | L | | | | |
| CO3 | M | H | | | | | | |

# Department of Electronics Engineering

M. Tech. (Electronics Engineering)

*Specialization: Communication & Information Systems*

**2016-17**

| | | | |
|---|---|---|---|
| **Course Number and Title** | **:** | **EL 601: Lab/Project/Design** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Core (II semester) | |
| Pre-requisite(s) | : | --- | |
| Contact Hours (L-T-P) | : | 3-1-0 | |
| Type of Course | : | Laboratory | |
| Course Assessment | : | Continuous assessment | (60%) |
| | | Endsem Examination (3 hours) | (40%) |

## Course Objectives

To develop simulation skills for different communication systems.

## Course Outcomes

After completing this course the students should be able to:

1. Learn MATLAB and its relevant tool boxes for communication and information systems.
2. Use these tools to design and analyse advanced communication systems;
3. Present the performed experiments in form of reports.

## Relationship of COs with POs

| **COs** | **POs** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h |
| CO1 | | | H | | | | | |
| CO2 | M | H | H | | | | M | |
| CO3 | | | | | H | | | |

# Department of Electronics Engineering

M. Tech. (Electronics Engineering)

*(Communication & Information Systems)*

**2016-17**

| | | | |
|---|---|---|---|
| **Course Number and Title** | **:** | **EL- 611 ELECTRONIC CIRCUITS** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Core (I Semester) | |
| Pre-requisite | : | --- | |
| Contact Hours (L-T-P) | : | 3-1-0 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Course Work | (15%) |
| | | Mid-sem Examination (1 hour) | (25%) |
| | | End-sem Examination (2 hour) | (60%) |

## Course Outcomes

On completing this course, students will be able to:

1. Design biasing circuits for ICs
2. Develop macro-models for specialized operational amplifiers and design circuits using these models
3. Analyse, design and test analog circuits

## Syllabus

**Function Generation Circuits**: Multiple section circuits, Triangular to sinusoidal wave converters, Log and antilog amplifiers. Analog multiplier/divider circuits. Four quadrant multipliers/dividers with n (n>2) inputs, Analog multipliers with digital output. Four-quadrant variable transconductance multiplier, balanced modulator as analog multiplier, polar Ex-OR. Phase detectors, Phase/frequency detector

**Waveform Generators**: Quadrature oscillators and four-phase oscillators, Voltage controlled and digitally controlled oscillators, Monolithic function generators

**Phase locked loops:** Simple PLL, Charge-pump PLLs, Non-ideal effects in PLL. Delay locked loops, Applications of PLL

**Specialized op-Amps:** OTAs, Norton amplifier, Programmable OP-Amps, Isolation amplifiers, Voltage sharing circuits, FN and V/F converters, Electronic attenuators

**Wide band amplifiers:** Design considerations, Cascode amplifiers, Differential video amplifiers, Amplifiers and oscillators using Current Conveyors

## References

3. Sidney Soclof, "Applications of Analog ICs", Prentice Hall of India, New Delhi. 1990.
4. 2. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", McGraw Hill, New Delhi, 2001.
5. 3. A.S. Sedra and K. C. Smith, "Microelectronic Circuits", Oxford University Press, 2000.
6. 4. J.M. Fiore, "Operational Amplifiers and Linear ICs - Theory and Applications", Jaico Publishing House, Delhi, 1999

**Relationship of COs with POs**

| COs | POs | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h |
| CO1 | | M | | L | | | | |
| CO2 | | M | | | | | | |
| CO3 | H | M | | | | | | |

# Department of Electronics Engineering

M. Tech. (Electronics Engineering)

*Specialization: Communication & Information Systems*

**2016-17**

| | | |
|---|---|---|
| **Course Number and Title** | : | **EL-651 Information and Coding Theory** |
| Credits | : | 4 |
| Course Category | : | Branch Core (I Semester) |
| Pre-requisite(s) | : | Fundamentals of Digital Communication |
| Contact Hours (L-T-P) | : | 3-1-0 |
| Type of Course | : | Theory |
| Course Assessment | : | Home Assignments (including MATLAB based problems and Quizzes) (15%) |
| | | Midsem Examination (1 hour) (25%) |
| | | Endsem Examination (3 hours) (60%) |

## Course Objectives

To understand the principles of Information theory and coding and their applications to design classical and modern source and channel codes.

## Course Outcomes

After completing this course the students should be able to:

1. Understand Shannon's Source coding, channel coding and information capacity theorems and their applications in contemporary areas of communication engineering.
2. Analyze and design source coding techniques for the different abstract sources.
3. Design and analyze the performance of classical error control codes.
4. Understand the coding and decoding methods based on graphs.
5. Implement and evaluate the performance of source and channel coding techniques using MATLAB.

## Syllabus

*Information Theory:* Relative Entropy and Mutual Information; Asymptotic Equipartition Property; Data Compression; Rate Distortion Theory; Differential Entropy; Channel Capacity; Gaussian Channel; Capacity of Wireless Channels

*Coding Theory:* Concepts of Abstract Algebra; Cyclic Codes: CRC, BCH and Reed-Soloman Codes; Reed-Muller Codes; Codes on Graphs: Convolutional Codes and Trellis Coded Modulation; Iteratively Decodable Codes: Turbo Codes and Low Density Parity Check Codes; Rateless Codes; Overview of Polar Codes

## References:

1. T M Cover and J A Thomas, *Elements of Information Theory*, John Wiley, 2006.

2. R E Blahut, *Algebraic Codes for Data Transmission*, Cambridge University Press, 2002.
3. Todd K Moon, *Error Correction Coding*, John Wiley, 2005.
4. Shu Lin and D J Costello, *Error Control Coding*, Prentice Hall, 2004.
5. R Bose, *Information Theory, Coding and Cryptography*, Tata McGraw Hill, 2008.
6. J G Proakis, *Digital Communication*, McGraw Hill, 2007.
7. http://www.mit.edu/~dawang/materials/fountain_codes.pdf
8. E Arikan, "Channel polarization: a method for constructing capacityachieving codes for symmetric binary-input memoryless channels", *IEEE Transactions on Information Theory*, vol. 55, no. 7, pp. 3051–3073, July 2009.

**Relationship of COs with POs**

| **COs** | **POs** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h |
| CO1 | H | | M | | | | | |
| CO2 | H | H | | | | | L | |
| CO3 | | H | | | | | L | |
| CO4 | H | | | M | | | | |
| CO5 | L | H | | | | L | | M |

# Department of Electronics Engineering

M. Tech. (Electronics Engineering)

*Specialization: Communication & Information Systems*

**2016-17**

| | | | |
|---|---|---|---|
| **Course Number and Title** | **:** | **EL-652 – Data Transmission Systems** | |
| Credits | : | 4 | |
| Course Category | : | Branch core (II semester) | |
| Pre-requisite(s) | : | Digital Communication | |
| Contact Hours (L-T-P) | : | 3-1-0 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Home Assignments | (15%) |
| | | Midsem Examination (1 hour) | (25%) |
| | | Endsem Examination (3 hours) | (60%) |

## Course Objectives

To understand the fundamentals of Communication theory and overview of different wired and wireless networks

## Course Outcomes

After completing this course the students should be able to:

1. Identify different types of waveforms for data transmission and to evaluate them on the basis of their spectrum, and synchronization capability.
2. Understand the principles of digital data transmission through band-limited channels including methods to reduce distortion and timing errors.
3. Design and investigate different types of equalizers for various kind of channels.
4. Understand the issues relating to narrowband and broadband modems, and to get an overview of different wired/wireless access networks.

## Syllabus

Overview of Data Representation and Communication; Line Coding and Baseband Shaping; Data Transmission Over Band-limited Channels; Voice-band Modems; Interfacing; Adaptive Equalization and Synchronization Techniques Used in High-speed Data Transmission; Modem Design Issues; Security Issues in Data Transmission; Data Compression; Error Control and Flow Control in Data Communications; Data Communication Over Contemporary Computer Networks; Data Transmission in Mobile Radio and Satellite Systems; Bandwidth Efficient Modulation & Coding Techniques; Multi Carrier Modulation and OFDM; Hierarchical Modulation and Applications; Digital Subscriber Loops (DSL); DSL Modem and Its Types; New and Advanced Data Transmission Systems

## Reference Books


1. A.P. Clark, *Principles of Digital Data Transmission*, Pentech Press, 1983.
2. John G. Proakis, *Digital Communications*, McGraw Hill, 2002.
3. Gilbert Held, *Understanding Data Communications*, 2nd Ed., John Wiley, 1996.
4. P.C. Gupta, *Data Communications*, Prentice Hall, 1996.
5. A.P. Clark, *Equalizers for Digital Modems*, Pentech Press, 1985.


## Relationship of COs with POs

| **COs** | **POs** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h |
| CO1 | H | H | | | | | | |
| CO2 | MH | H | | | | | | |
| CO3 | M | M | H | | | | L | |
| CO4 | M | M | H | | | | L | |

# Department of Electronics Engineering

M. Tech. (Electronics Engineering)

*Specialization: Communication & Information Systems*

**2016-17**

| | | |
|---|---|---|
| **Course Number and Title** | : | **EL-657 Secure Communication** |
| Credits | : | 4 |
| Course Category | : | Elective (II Semester) |
| Pre-requisite(s) | : | Information and Coding Theory |
| Contact Hours (L-T-P) | : | 3-1-0 |
| Type of Course | : | Theory |
| Course Assessment | : | Home Assignments (including MATLAB based problems and Quizzes) (15%) |
| | | Midsem Examination (1 hour) (25%) |
| | | Endsem Examination (3 hours) (60%) |

## Course Objectives

To provide a solid grounding in the relevent algorithms, protocols and techniques involved in the design of security systems for communication networks.

## Course Outcomes

After completing this course the students should be able to:

6. Understand the concepts and applications of cryptography and network security.
7. Apply security principles to system design
8. Analyse and describe modern and classical techniques of cryptography.
9. Present an overview of user authentication and network security.

## Syllabus

Introduction to Secure Communication; Cryptography, Watermarking and Steganography; Cryptanalysis

Basic Number Theory; Primality Testing; Factoring Integers; Square Roots in Prime Fields

Information Theoretic Methods in Cryptography

Substitution and Transposition Ciphers; Block and Stream Ciphers; Hash Functions

Cryptography Based on Integer Rings; Discrete Logarithm; Cryptography Based on Discrete Logarithm; Elliptic Curve Cryptography

Digital Signatures; User Authentication; Network Security

## References:


9. W Stallings, Cryptography and Network Security, Pearson Education, 2014.
10. B Forouzan, Cryptography and Network Security, McGraw Hill, 2010.

11. C Paar and J Pelzl, Understanding Cryptography, Springer, 2010.
12. R E Blahut, Cryptography and Secure Communication, Cambridge University Press, 2014.
13. B Schneier, Applied Cryptography, John Wiley, 1995.

14. E Arikan, "Channel polarization: a method for constructing capacityachieving codes for symmetric binary-input memoryless channels", *IEEE Transactions on Information Theory*, vol. 55, no. 7, pp. 3051–3073, July 2009.

**Relationship of COs with POs**

| **COs** | **POs** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h |
| CO1 | M | H | | M | | H | | L |
| CO2 | H | H | M | M | | | M | |
| CO3 | H | H | M | M | | | | |
| CO4 | L | M | M | L | | H | | L |

# Department of Electronics Engineering

M. Tech. (Electronics Engineering)

*(Communication & Information Systems)*

**2016-17**

| | | | |
|---|---|---|---|
| **Course Number and Title** | : | **EL-658 Wireless Communication** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Elective (II semester) | |
| Pre-requisite | : | Course on Digital Communication | |
| Contact Hours (L-T-P) | : | 3-1-0 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Course Work | (15%) |
| | | Midsem Examination (1 hour) | (25%) |
| | | Endsem Examination (2 hour) | (60%) |

## Course Objective:

To understand the insight of wireless communication system, perfromance analysis and familar with design aspects of emerging wireless systems.

## Course Outcomes

On completing this course, students will be able to:

6. Determine the characteristics of wireless channel.
7. Identify the challenges and possible solutions for wireless communication.
8. Analyze the performance of wireless communication system.
9. Become familiar with the design aspects of some of the existing and emerging wireless systems.

## Syllabus *(Effective from 2012-13)*

Narrowband and Wideband Channel Models; Capacity of Flat and Frequency-Selective Fading Channels; Performance in Fading Channels; Diversity Modeling for Wireless Communications; Orthogonal Frequency-Division Multiplexing (OFDM); OFDMA and Single-Carrier FDMA; Multi-Input Multi-Output (MIMO) System: Spatial Multiplexing and Channel Modeling, Capacity and Multiplexing Architectures; Multiuser Systems: Multiuser Capacity and Opportunistic Communication, Multiuser Diversity.

## References

7. D. Tse and P. Viswanath, *Fundamentals of Wireless Communication*, Cambridge Univ. Press, 2005
8. A. S. Goldsmith, *Wireless Communications*, Cambridge Univ. Press, 2005
9. A. F. Molisch, *Wireless Communications*, John Wiley & Sons Ltd., 2nd Edition, 2011
10. E. Biglieri, *MIMO Wireless Communications*, Cambridge Univ. Press, 2007

**Relationship of COs with POs**

| **COs** | **POs** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h |
| CO1 | M | H | H | | | | | |
| CO2 | | H | | | | | | |
| CO3 | H | H | L | | | | | |
| CO4 | | M | M | | | | L | |

# Department of Electronics Engineering

M. Tech. (Electronics Engineering)

*Specialization: Communication & Information Systems*

**2016-17**

| | | |
|---|---|---|
| **Course Number and Title** | **:** | **EL-661 Advanced Digital Signal Processing** |
| Credits | : | 4 |
| Course Category | : | Branch Core (II semester) |
| Pre-requisite(s) | : | Digital Signal Processing |
| Contact Hours (L-T-P) | : | 3-1-0 |
| Type of Course | : | Theory |
| Course Assessment | : | Home Assignments (including MATLAB based problems) (15%)<br>Midsem Examination (1 hour) (25%)<br>Endsem Examination (3 hours) (60%) |

## Course Objectives

To understand the advance topics in digital signal processing such as concept of multi-rate digital signal processing using filter bank approach and design of adaptive filters.

## Course Outcomes

After completing this course the students should be able to:

1. Acquire the basics of multi rate digital signal processing.
2. Learn and implement time-frequency analysis techniques.
3. Able to independently learn and implement adaptive signal processing algorithms
4. Analyze the power spectrum estimation
5. Learn the essential advanced topics in DSP that are necessary for successful Postgraduate level research

## Syllabus

**Multi-rate Signal Processing**
Polyphase Decomposition: decimation, interpolation, filter banks, analysis and filter banks; Quadrature mirror filters

**Multi-Resolution Analysis of Wavelets**
Short term Fourier Transform; wavelet transform: Discrete time wavelet Transform; time frequency localization

**Wiener Filtering**
Principle of orthogonality; wiener Hopf equations; IIR Wiener filters, FIR Wiener filters

**Linear Prediction**
Forward linear prediction; backward linear prediction, Levinson Durban algorithm; Lattice predictors

**Adaptive Filtering**
Examples of adaptive filters, Method of steepest Descent; LMS algorithm; recursive least square method

**Power Spectrum Estimation**
Introduction: maximum likelihood estimation; estimates of autocorrelation sequences, Non-parametric and parametric spectral estimation

## Reference Books


1. Simon Haykin, Adaptive filter Theory, Pearson Education 2013.
2. S K Mitra, Digital Signal Processsing: A computer based approachTata Mczgraw Hill, 2010.
3. John G. Proakis and Dimitris G. Manolakis, Digital Signal Processing: Principles, Algorithms, and Applications, 3rd Edition, Prentice Hall


## Relationship of COs with POs

| COs | POs | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h |
| CO1 | H | M | M | M | | | | |
| CO2 | H | L | M | M | | | | |
| CO3 | M | M | H | M | | | M | |
| CO4 | H | | M | | | | | |
| CO5 | H | M | LL | H | | | | M |

# Department of Electronics Engineering

M. Tech. (Electronics Engineering)

*Specialization: Communication & Information Systems*

**2016-17**

| | | |
|---|---|---|
| **Course Number and Title** | **:** | **EL662 – Speech Processing** |
| Credits | : | 4 |
| Course Category | : | Departmental Elective (I semester) |
| Pre-requisite(s) | : | --- |
| Contact Hours (L-T-P) | : | 3-1-0 |
| Type of Course | : | Theory |
| Course Assessment | : | Home Assignments (including MATLAB based problems) (15%)<br>Midsem Examination (1 hour) (25%)<br>Endsem Examination (3 hours) (60%) |

## Course Objectives

To understand the speech signal production and properties, design algorithms for speech signal processing and speech recognition system.

## Course Outcomes

After completing this course the students should be able to:

10. Understand the speech production and perception process
11. Analyze speech signals in terms of time and frequency domain properties
12. Synthesize speech signals in terms of time and frequency domain properties
13. Design and implement algorithms for processing speech signals
5. Build a simple speech recognition system

## Syllabus

Human Vocal Auditory System; Speech Production Model; Classification of Speech Sounds; Speech Analysis Techniques: Pitch Detection, Endpoint Detection, Voiced/Unvoiced Detection; Speech Synthesis Techniques: Formant Based Synthesizer (KLATT Synthesizer); Speech Compression: ADPCM, Linear Predictive Coders, Analysis by Synthesis Technique, Speech and Audio Coding Standards; Speech Recognition: Feature Extraction, Mel Frequency Cepstral Coefficients, Hidden Markov Model, Enhancement of Noisy Speech

## Reference Book


1. J. R. Deller, J. R. Proakis and J. H. L. Hansen, *Discrete-time Processing of Speech signals*, Prentice Hall, 1993.
2. L. Rabiner and R. Shafer, *Digital Processing of Speech signals*, Pearson Education, 1993.

3. D. G. Childers, *Speech Processing and Synthesis Toolboxes*, John Wiley and Sons, 2000.

**Relationship of COs with POs**

| COs | POs | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h |
| CO1 | H | | | | | | | |
| CO2 | H | | | M | | | | |
| CO3 | H | | M | M | | | | |
| CO4 | | H | M | | | L | L | |
| CO5 | H | M | M | | | | M | |

# Department of Electronics Engineering

M. Tech. (Electronics Engineering)

*Specialization: Communication & Information Systems*

**2016-17**

| | | |
|---|---|---|
| **Course Number and Title** | : | **EL-663 Image and Video Processing** |
| Credits | : | 4 |
| Course Category | : | Departmental Elective (II semester) |
| Pre-requisite(s) | : | Digital Signal Processing & Digital Communication |
| Contact Hours (L-T-P) | : | 3-1-0 |
| Type of Course | : | Theory |
| Course Assessment | : | Home Assignments (including MATLAB based problems and Quizzes) (15%)<br>Midsem Examination (1 hour) (25%)<br>Endsem Examination (3 hours) (60%) |

## Course Objectives

To understand the basic principles and tools used to process images and videos, and how to apply them in solving practical problems of commercial and scientific interests.

## Course Outcomes

After completing this course the students should be able to:

5. Describe and analyse images and videos as 2-D and 3-D signals in spatial, spatio-temporal and frequency domains.
6. Understand how image and videos (including colours) are perceived by human visual system.
7. Understand fundamental image processing tasks including image enhancement, image restoration and compression.
8. Implement and apply various image processing tasks in practice using modern techniques and tools.
9. Understand fundamentals of video coding techniques and various video coding standards.

## Syllabus

Digital Image Fundamentals; Image Transforms; Image Enhancement; Image Restoration; Compression of Binary Images and Their Standards; Grey Scale and Colour Image Compression; JPEG and JPEG2000 Standards; Image Segmentation; Image Recognition and Interpretation;

Basic Principles and Standards for Video; Video Coding and Compression Fundamentals; Video Coding Standards Such as H.261, H.263, MPEG-1, MPEG-2, and MPEG-4; Video Streaming; Digital Video Broadcasting; Video Conferencing and Video on Demand Systems

**Text Book(s)**


1. Anil K. Jain, “Fundamentals of Digital Image Processing”, Prentice-Hall, 1995.
2. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing, 3rd edition", Prentice Hall, 2008.
3. M. Ghanbari, “Video coding: an introduction to standard codecs”, IEE Press, London, 1999.


**Reference Book(s)**


1. K. R. Rao and J. J. Hwang, “Techniques and Standards for Image, Video and Audio Coding”, Prentice-Hall, 1996.
2. William K. Pratt, “Digital Image Processing”, Third Edition, John Wiley, 2003.


**Relationship of COs with POs**

| COs | POs | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h |
| CO1 | H | M | M | | | | | L |
| CO2 | M | | | H | | | | |
| CO3 | H | M | M | | | | | |
| CO4 | | M | H | L | | | M | |
| CO5 | L | M | M | | | | | M |

# Department of Electronics Engineering

M. Tech. (Electronics Engineering)

*Specialization: Communication & Information Systems*

**2016-17**

| | | | |
|---|---|---|---|
| **Course Number and Title** | **:** | **EL672 – Special Purpose Radars** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Elective (II semester) | |
| Pre-requisite(s) | : | --- | |
| Contact Hours (L-T-P) | : | 3-1-0 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Home Assignments | (15%) |
| | | Midsem Examination (1 hour) | (25%) |
| | | Endsem Examination (3 hours) | (60%) |

## Course Objectives

To understand the basic techniques, measure, different landing systems and different types of special purpose radar.

## Course Outcomes

After completing this course the students should be able to:

1. Understand pulse compression techniques.
2. Understand various types of Electronic Counter Measure and Counter Counter Measure.
3. Analyse different types of special purpose Radars.
4. Understand the principles of navigational aids.
5. Understand the principles of Instrument Landing Systems and Microwave Landing Systems.

## Syllabus

Pulse Compression Techniques; Radar Beacons; Track While Scan (TWS) Radar; Millimeter Wave (MMW) Radar; Laser Radar; Military Radars; Over The Horizon (OTH) Radar, Radar Astronomy

Terrain Following; Terrain Avoidance; Weather Avoidance and Instrumentation Radars; Radar Altimeters,Synthetic Aperture Radar (SAR); Radar Meteorological Echoes; Multiple Target Detection Techniques

Direction Finders; Long Wave Radio Ranging; Very High Frequency Omni Range (OR); Long Range Air Navigation (LORAN); DECCA; Hyperbolic Systems/DME, TACAN, VORTEC

Introduction to Navigation; Radar Navigation; Satellite Navigation; Inertial Navigation; Aircraft Landing Systems (ILS/MLS/GCA)

## Reference Books


1. Hovanessian, S.A., *Radar System Design and Analysis*, Artech House, 1984.
2. Nagaraja, N.S., *Elements of Electronic Navigation*, 2nd ed., Tata McGraw Hill, New Delhi, 1996.


## Relationship of COs with POs

| **COs** | **POs** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h |
| CO1 | M | H | | | | | | |
| CO2 | M | M | | L | | | | |
| CO3 | H | | M | M | | | | |
| CO4 | | | | M | | M | | |
| CO5 | | | M | | | | | |

# Department of Electronics Engineering

M. Tech. (Electronics Engineering)

*Specialization: Communication & Information Systems*

**2016-17**

| | | | |
|---|---|---|---|
| **Course Number and Title** | **:** | **EL673 – RF and Microwave Devices & ICs** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Elective (II semester) | |
| Pre-requisite(s) | : | Course on IC design | |
| Contact Hours (L-T-P) | : | 3-1-0 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Home Assignments | (15%) |
| | | Midsem Examination (1 hour) | (25%) |
| | | Endsem Examination (3 hours) | (60%) |

## Course Objectives

To learn the design and carry out performance analysis of RF circuits used in emerging wireless area.

## Course Outcomes

After completing this course the students should be able to:

1. Gain an exposure of emerging wireless systems and understand their working
2. Carry out performance analysis
3. Use specialized RF tool
4. Design RF circuits with feasibility in IC form
5. Prepare presentation based on topics related to the subject area

## Syllabus

3G Wireless Systems; Device and Technology Requirements – Multiple Gates MOSFETs; RF Characterization of Deep Sub-micron CMOS; Key Figure of Merits: Unity Gain Frequency, $f_T$, Maximum Frequency of Oscillation, $f_{max}$; Noise; Comparison of RF Technologies; RF Front-end Blocks; Low Noise Amplifier (LNA) and Power Amplifier (PA); LNA Topologies: Power and Noise Match; High Efficiency PAs; Power Gain and Stability; Microwave Integrated Circuits (MICs) – Micro-strip Lines and Strip Lines, MIC Types and Their Applications

## Reference Books


3. T.H. Lee, *The Design of CMOS Radio-Frequency Integrated Circuits*, 2004.
4. T. Ytterdal, Y. Chang and T.A. Fjeldly, 2004, *Device Modeling for Analog and RF CMOS Circuit Design*, 2004.

5. Ulrich L. Rohde and D.P. Newbrick, *RF/Microwave Circuit Design for Wireless Applications*, 2005.
6. Kai Chang, Inter Bahal and Vijay Nair, *RF and Microwave Circuit and Component Design for Wireless System*, 2002.
7. B. Razavi, *RF Microelectronics*, Prentice Hall, 2005.
8. M.M. Radmanesh, *Radio Frequency and Microwave Electronics – Illustrated*, Pearson Education, 2001.
9. S.Y. Liao, *Microwave Devices and Circuits*, Prentice Hall of India, 2003.

## Relationship of COs with POs

| COs | POs | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h |
| CO1 | H | | | | | | | |
| CO2 | M | H | | | | | | |
| CO3 | | | H | | | | | |
| CO4 | | H | H | | | | M | |
| CO5 | | | | L | M | | | |

# Department of Electronics Engineering

M. Tech. (Electronics Engineering)

*(Communication & Information Systems)*

**2016-17**

| | | | |
|---|---|---|---|
| **Course Number and Title** | : | **EL- 681 Computer Networks** | |
| Credits | : | 4 | |
| Course Category | : | Departmental Core (I semester) | |
| Pre-requisite | : | Nil | |
| Contact Hours (L-T-P) | : | 3-1-0 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Course Work | (15%) |
| | | Midsem Examination (1 hour) | (25%) |
| | | Endsem Examination (2 hour) | (60%) |

**Course Objectives:**

- To gain an understanding of the concepts in computer networking.
- Familiarize students with the basic network protocols and security issues.

## Course Outcomes

After completing the course the students shall be able to:

1. Explain data communication system models
2. Apply queuing model to computer network
3. Understand routing mechanisms and build the skills of subnetting
4. Identify different types of network devices and their functions
5. Illustrate the functionalities of different blocks in a TCP/IP network

## Syllabus

Overview of OSI; Data link Contol and its Protocol; LANs and their types; High speed and Bridged LANs; ISDN; X.25 and Frame Relay; ATM; SONET/SDH; Routing; Upper OSI Layers; Interworking Concepts, architecture and protocols; IP addressed and datagram forwarding; TCP/IP protocol suite; Data compression for modern networks; Network security; Home and small office networks; New evolving networks

**Books/References:**


1. B.A. Forouzan, “Data Communications and Networking”, 4th Edition, Tata Mc Graw Hill.
2. William Stallings, “Data and Computer Communications”, 8th Edition, Pearson

3. Andrew S. Tanenbaum, “Computer Networks”, 4th Edition, Pearson.
4. Fred Halsall, “Data Communications, Computer Networks and Open Systems”, Addision Wesley, 1996.
5. Douglas E. Cover, “Computer Networks and Internets”, Prentice Hall, 1997.
6. M.A. Gallo and W.M. Hancock, “Computer Communications and Networking Technologies”, Thomson, 2002.

**Relationship of COs with POs**

| COs | POs | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h |
| CO1 | L | M | | | | | | |
| CO2 | H | M | M | | | | | |
| CO3 | | M | M | | | | L | |
| CO4 | | H | | | | | | |
| CO5 | | H | M | | | | | M |

# Department of Electronics Engineering

M. Tech. (Electronics Engineering)

**2016 – 17**

| | | | |
|---|---|---|---|
| **Course Number and Title** | **:** | **Ad Hoc and Sensor Networks** | |
| Course Number | : | EL-686 | |
| Credits | : | 4 | |
| Course Category | : | DE | |
| Pre-requisite(s) | : | EL-681 | |
| Contact Hours (L-P-G) | : | 3-0-1 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Home Assignments | (15%) |
| | | Midsem Examination (1 hour) | (25%) |
| | | Endsem Examination (3 hours) | (60%) |

## Course Objectives

This course introduces the diverse topics on ad-hoc/sensor networks, and exposes the students to the fundamental issues in designing and analyzing ad-hoc/sensor network systems. The emphasis will be on protocol design, communication and computational challenges posed by these systems.

## Course Outcomes (CO)

*On completing this course, students will be able to:*

1. Discuss the unique issues in Ad Hoc/Sensor networ and Cognetive Radios
2. Differentiate the different MAC protocols for Ad Hoc/Sensor networ
3. Compare the different routing and transport protocols for the Ad Hoc/Sensor networ
4. Understand the reliability and security issues of sensor network

## Syllabus:

Introduction to Ad hoc and Sensor Networks; Media Access Control: Issues, Classifications and Protocols; Routing in Ad hoc Networks; Sensor Network Architecture; Sensor Tasking and Control; Transport and Security Protocols; Sensor Network Programming Challenges; Embedded Operating Systems; Overview of Cognitive Radio Communication; Future Directions

***Text / Reference Books:***


1. C S Murthy & B S Manoj, *Ad hoc Wireless Networks*, Pearson Education, 2011
2. I F Akhyildis & M C Vuran, *Wireless Sensor Networks*, John Wiley, 2010
3. C M Cordeiro & D P Agrawal, *Ad Hoc & Sensor Networks*, World Scientific, 2011
4. F Hu & X Cao, *Wireless Sensor Networks*, CRC Press, 2010
5. A Wyglinski, M Nekovee & T Hou, *Cognitive Radio Communications and Networks*, Elsevier, 2009
6. K Sinha, S C Ghosh and B P Sinha, *Wireless Networks and Mobile Computing*, CRC Press, 2016

7. S Basagni and M Conti, *Mobile Ad Hoc Networking: The Cutting Edge Direction*, Wiley, 2015
8. W Dargie and C Poellabauer, *Fundamentals of Wireless Sensor Networks: Theory and Practice*, Wiley, 2014

**Relationship of COs with POs**

| **COs** | **POs** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h |
| CO1 | M | L | | L | | M | | |
| CO2 | M | H | | H | | | | |
| CO3 | M | H | | H | | | L | |
| CO4 | M | M | | M | | M | | |

# Department of Electronics Engineering

M. Tech. (Electronics Engineering)

*Specialization: Communication & Information Systems*

**2016-17**

| | | | |
|---|---|---|---|
| **Course Number and Title** | : | **EL-745: Artificial Neural Network and Applications** | |
| Credits | : | 4 | |
| Course Category | : | Elective | |
| Pre-requisite(s) | : | -- | |
| Contact Hours (L-T-P) | : | 3-1-0 | |
| Type of Course | : | Theory | |
| Course Assessment | : | Home Assignments | (15%) |
| | | Midsem Examination (1 hour) | (25%) |
| | | Endsem Examination (3 hours) | (60%) |

## Course Objectives

To understand the concept of .Artificial Neural Networks and design specific ANN architectures for different problem domains.

## Course Outcomes

After completing this course the students should be able to:

1 Understand the concepts Artificial Neural Networks (ANN)
2 Develop knowledge of basic ANN architectures
3 Analyze ANN systems
4 Design specific ANN architectures for different problem domains

## Syllabus

Biological Foundations of Neural Networks; Early Neural models Network Architecture: Single Layer Perceptrons, Multi-Layer Perceptrons; Recurrent Networks Learning Processes: Supervised, Unsupervised; Design Issues: Pre-processing, Input and Output Encoding; Structure of Networks; Training, Validation and Testing the Prototype; Visualisation Methods: Clustering, Self-organising Maps, Sammon Maps; ANN Hardware and Implementation Concern; Applications: Pattern Recognition, Pattern Analysis, Time Series Prediction; System Identification, Adaptive Control

## Reference Books


1. Simon Haykin, *Neural Networks: A Comprehensive Foundation*, 2nd edition, Pearson Education Asia, 2001.
2. Robert J. Schalkoff, *Artificial Neural Networks*, McGraw Hill International edition, 1997.

**3.** D. L. Hudson and M. E. Cohen, *Neural Networks and Artificial Intelligence for Biomedical Engineering*, Prentice Hall of India, 2001

**Relationship of COs with POs**

| **COs** | **POs** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h |
| CO1 | M | | | M | | | | |
| CO2 | M | H | | L | | | | |
| CO3 | | M | H | | | | | |
| CO4 | | H | | H | | | M | |

# Department of Electronics Engineering

M. Tech. (Electronics Engineering)

*Specialization: Communication & Information Systems*

**2016-17**

| | | | |
|---|---|---|---|
| **Course Number and Title** | **:** | **EL 780C: General Seminar** | |
| Credits | : | 2 | |
| Course Category | : | Departmental Core (III semester) | |
| Pre-requisite(s) | : | -- | |
| Contact Hours (L-T-P) | : | 0-0-2 | |
| Type of Course | : | Seminar | |
| Course Assessment | : | Course work | (60%) |
| | | End semester | (40%) |

## Course Objectives

To develop technical presentation and report writing skills

## Course Outcomes

After completing this course the students should be able to:

1. Carry out literature survey independently to understand the selected topics
2. Prepare a critical report of the literature survey
3. Effectively present and defend the findings

## Relationship of COs with POs

| **COs** | **POs** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h |
| CO1 | | | | M | | L | | H |
| CO2 | L | | | | H | | | |
| CO3 | | | | | H | | | |

# Department of Electronics Engineering

M. Tech. (Electronics Engineering)

*Specialization: Communication & Information Systems*

**2016-17**

| | | |
|---|---|---|
| **Course Number and Title** | **:** | **EL 781C: Preliminary Dissertation Seminar** |
| Credits | : | 3 |
| Course Category | : | Departmental Elective (III semester) |
| Pre-requisite(s) | : | -- |
| Contact Hours (L-T-P) | : | 0-0-3 |
| Type of Course | : | Dissertation |
| Course Assessment | : | Continuous assessment (60%) |
| | | End Sem Examination (40%) |

## Course Outcomes

After completing this course the students should be able to:

1. Identify, analyse and formulate research problem in the related area
2. Prepare a critical review of the related work and give effective presentation
3. Comprehend the research problem with understanding of ethical, professional and social responsibilities

## Relationship of COs with POs

| **COs** | **POs** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h |
| CO1 | M | | | H | | | | |
| CO2 | | | | | H | | | H |
| CO3 | | | | | | H | | |

# Department of Electronics Engineering

M. Tech. (Electronics Engineering)

*Specialization: Communication & Information Systems*

**2016-17**

| | | | |
|---|---|---|---|
| **Course Number and Title** | **:** | **EL 782C: Final Dissertation Seminar** | |
| Credits | : | 2 | |
| Course Category | : | III semester | |
| Pre-requisite(s) | : | -- | |
| Contact Hours (L-T-P) | : | 0-0-3 | |
| Type of Course | : | Dissertation | |
| Course Assessment | : | Continuous assessment | (60%) |
| | | End semester examination | (40%) |

## Course Outcomes

After completing this course the students should be able to:

1 Effectively present the solution of the identified problem
2 Draw inferences on the basis of findings
3 Defend the findings by effective presentation

## Relationship of COs with POs

| **COs** | **POs** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h |
| CO1 | | | | | H | | | |
| CO2 | | | | | | | | H |
| CO3 | M | M | | H | | | | H |

# Department of Electronics Engineering

M. Tech. (Electronics Engineering)

*Specialization: Communication & Information Systems*

**2016-17**

| | | | |
|---|---|---|---|
| **Course Number and Title** | **:** | **EL791C Lab/Project** | |
| Credits | : | 3 | |
| Course Category | : | Departmental Core (III semester) | |
| Pre-requisite(s) | : | --- | |
| Contact Hours (L-T-P) | : | 0-3-0 | |
| Type of Course | : | Project | |
| Course Assessment | : | Course work | (60%) |
| | | End sem Examination | (40%) |

## Course Objectives

To develop the skills to build small projects in technical area.

## Course Outcomes

After completing this course the students should be able to:

1 Identify, analyse and formulate real world problem
2 Apply the knowledge and skills gained to solve engineering problem
3 Develop written and oral presentation skills
4 Think innovatively to solve and manage engineering problems effectively

## Relationship of COs with POs

| **COs** | **POs** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h |
| CO1 | M | | | H | | | | |
| CO2 | | H | H | M | | | | |
| CO3 | | | | | H | | | |
| CO4 | | | | | | | H | H |

# Department of Electronics Engineering

M. Tech. (Electronics Engineering)

*Specialization: Communication & Information Systems*

**2016-17**

| | | | |
|---|---|---|---|
| **Course Number and Title** | **:** | **EL 798: Dissertation** | |
| Credits | : | 10 | |
| Course Category | : | Departmental core (IV semester) | |
| Pre-requisite(s) | : | -- | |
| Contact Hours (L-T-P) | : | 0-0-3 | |
| Type of Course | : | Dissertation | |
| Course Assessment | : | Course work | (60%) |
| | | End Semester examination | (40%) |

## Course Outcomes

After completing this course the students should be able to:

1. Apply the knowledge and skills gained to design and solve the research problem in the relevant field
2. Think innovatively to solve and manage engineering problems effectively
3. Comprehend the research problem with understanding of ethical, professional and social responsibilities
4. Present the work done through technical report and oral presentation

## Relationship of COs with POs

| **COs** | **POs** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h |
| CO1 | H | H | H | H | | | | |
| CO2 | | | | | | | H | H |
| CO3 | | | | | | H | | |
| CO4 | | | | | H | | | |