Master of Technology
(Electronics and Communication Engineering)

Regulations, Curriculum and Syllabus
(CBCS & Non CBCS)

(with effect from academic year 2018-2019)
i) CBCS Regulations for M.Tech. (Electronics and Communication Engineering)

The Department of Electronics Engineering under the School of Engineering and Technology, Pondicherry University, Pondicherry has been started in the academic year 2010 – 2011 with Master of Technology (M.Tech) programme in Electronics.

Besides the Choice Based Credit System (CBCS) regulations specified by Pondicherry University in respect of engineering post graduate degree admission, evaluation and awarding degree, the following norms are applicable for this programme.

<table>
<thead>
<tr>
<th>Name of the Programme</th>
<th>M.Tech. (Electronics and Communication Engineering)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature of Programme</td>
<td>Regular, Coming under Engineering Department.</td>
</tr>
<tr>
<td>Programme Duration</td>
<td>Two years (Four Semesters). However, one can complete the programme within maximum of eight semesters.</td>
</tr>
<tr>
<td>Eligibility Criteria</td>
<td>In addition to University regulations in respect of passing marks at undergraduate level and other criteria, candidates who are holding any one of the following degrees alone shall be considered for this M.Tech Programme: B.E / B.Tech in Electronics/ Electronics and Communication Engineering/ Electronics and Telecommunication Engineering with a minimum of 55% of marks.</td>
</tr>
<tr>
<td>Admission Criteria</td>
<td>Based on Pondicherry University’s All India Entrance Examination.</td>
</tr>
<tr>
<td>Intake</td>
<td>30 Students per year</td>
</tr>
<tr>
<td>Teaching and Learning Methods</td>
<td>Lectures, tutorials and seminars are the main methods of course delivery, which would be supplemented by individual practical work, project work, simulation assignment, seminars and industrial visits.</td>
</tr>
<tr>
<td>Minimum number of credits to be acquired for successful completion of the programme</td>
<td>74 Credits</td>
</tr>
</tbody>
</table>
**Assessment Methods**

CBCS is the method of assessment with the following weightage of marks for the various courses of the programme.

**For Theory Courses:** 40% of marks for internal and 60% for end semester examinations.

The end semester question paper will have Part A (6 × 2 = 12 Marks) consisting of six two mark questions and Part B (4 × 12 = 48 Marks) consisting of six twelve mark descriptive questions of which one of them is compulsory and totally a candidate has to answer four out of six. For the end semester examination (University Semester Examination), the questions will be chosen only from the first four units of every theory subject of the programme to account end semester marks of 60 and internally (cumulatively) to assess a candidate’s depth of knowledge in the concerned subject for 40 marks, a minimum of two internal tests (30 marks) shall be conducted. Further, the content of the fifth unit in each subject shall be considered to conduct seminars, tutorials, simulations, assignments, development of hardware models etc. for 10 marks as it is formulated at system level for all subjects of the programme. The question paper setter will be appointed by the Competent Authority of the University. However, the evaluation shall be carried out by both internal and external examiners.

**For Practical Courses:** 40% of marks for internal and 60% for end semester examinations.

**For Internship / Seminar/ Workshop / Conference / FDP / Short term course / NPTEL/GIAN/MOOC Course:**

100% of marks through internal assessment only.

It is optional to undergo internship in established industry or esteemed institution / Seminar/ Workshop / Conference / FDP / Short term course / NPTEL/GIAN/MOOC Course for a period of four weeks (20 working days) either in single or multiple spans by a candidate. Further, a presentation should be given regarding the training or programme underwent during the period with the submission of a report. There shall not be any end semester evaluation. However, the internal evaluation is done by the committee comprising of internal members and one external member from other department of the same institute constituted by Head of the Department for the award of appropriate grade to the candidate based on the performance. The distribution of marks will be decided by the committee. The internship / Seminar/ Workshop / Conference / FDP / Short term course / NPTEL/GIAN/MOOC Course can be completed at any period of the duration of M.Tech. programme to fulfill the partial requirements for the award of M.Tech. degree.
**NPTEL/GIAN/MOOC Course:**
It is mandatory to undergo one course related to the chosen programme for the minimum period of 30 hours either from NPTEL or GIAN or MOOC that is to be completed at any period of the duration of M.Tech. programme to fulfill the partial requirements for the award of M.Tech. degree. Absolute grade shall be awarded to a candidate based on the marks given in the certificate issued by the competent authority (NPTEL or GIAN or MOOC) for the chosen course.

**Project - Literature Survey:** 100% of marks through internal assessment only.

It is mandatory to undergo a complete literature survey by a candidate on the area of project work in the third semester regularly. There will be two reviews for the candidate on the literature survey carried out. There shall not be any end semester evaluation. However, the internal evaluation is based on the presentation of the candidate with the submission of a report about the literature survey. It will be done by the committee comprising of internal members and one external member from other department of the same institute constituted by Head of the Department for the award of appropriate grade to the candidate based on the performance. The distribution of marks for the literature survey will be decided by the committee.

**For Project and Viva Voce:** 75% of marks for internal and 25% for end semester examinations.

The Project work shall be evaluated for a maximum of 100 marks. There shall be three assessments during the fourth semester by a review committee. The Head of the Department shall constitute the review committee consisting of supervisor, project coordinator and another faculty member from the Department for the internal assessment (50 marks). The contribution by the respective supervisor of a student for 25 marks shall be accounted for the internal marks of 75. The end semester Project Viva Voce (for 25 marks) shall be conducted by the external member nominated by the competent Authority of the University. The distribution of the marks is shown in the Table given below.

<table>
<thead>
<tr>
<th>Allocation of Marks for Project and Viva Voce (100 Marks)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Internal (75 Marks)</strong></td>
</tr>
<tr>
<td>Review Committee (50 Marks)</td>
</tr>
<tr>
<td>Supervisor (25 Marks)</td>
</tr>
<tr>
<td><strong>External (25 Marks)</strong></td>
</tr>
<tr>
<td><strong>Total (100 Marks)</strong></td>
</tr>
<tr>
<td>First Review</td>
</tr>
<tr>
<td>Second Review</td>
</tr>
<tr>
<td>Third Review</td>
</tr>
<tr>
<td>10 Marks</td>
</tr>
<tr>
<td>20 Marks</td>
</tr>
<tr>
<td>20 Marks</td>
</tr>
<tr>
<td>25 Marks</td>
</tr>
<tr>
<td>25 Marks</td>
</tr>
<tr>
<td>100 Marks</td>
</tr>
</tbody>
</table>
**Publication:** Mandatory requirement for the completion of the programme.

It is mandatory to have a minimum of one submitted manuscript / accepted publication in reputed journal during the M.Tech. programme. However, the submitted manuscript / accepted paper is subject to the recommendation of the evaluating committee comprising of internal members from same Department constituted by Head of the Department and one external member (examiner) from other institute nominated by competent Authority of University for the acceptance of the quality of the manuscript /paper of the candidate. The publication can be made at any period of the duration of M.Tech. programme. However, it does not contribute any credits to the programme but mandatory to fulfill the partial requirements for the award of M.Tech. degree. This evaluation process may be carried out along with even end semester examination depending up on the status of the students.

**Non Compliance:**
Non complaining the requirements of any course(s) by a candidate at any period of the duration of programme shall lead to warrant the implementation of prevailing University CBCS regulations.
ii) **Non – CBCS Regulations for M.Tech. (Electronics and Communication Engineering)**

Besides the Non - CBCS regulations specified by Pondicherry University in respect of engineering post graduate degree admission, evaluation and awarding degree, the following norms are applicable for this programme.

1. **Name of the Programme** : M.Tech. (Electronics and Communication Engineering)

2. **Nature of the Programme** : Regular, Coming under Engineering Department.

3. **Programme Duration** : Two years (Four Semesters). However, one can complete the programme within maximum of eight semesters.

4. **Eligibility Criteria** : In addition to University regulations in respect of passing marks at undergraduate level and other criteria, candidates who are holding any one of the following degrees alone shall be considered for this M.Tech Programme: B.E / B.Tech in Electronics/ Electronics and Communication Engineering/ Electronics and Telecommunication Engineering or equivalent with a minimum of 55% of marks.

   **Note:**
   i. Candidates belonging to SC/ST who have a mere pass in the qualifying examination are eligible (as per university norms).
   ii. There is no age limit for M.Tech programmes.

5. **Admission Criteria** : The admission policy for various M.Tech programmes will be decided by the respective institutes offering M.Tech programmes subject to conforming to the relevant regulations of the Pondicherry University.

6. **Intake** : As per the sanctioned strength to the Institute by the Pondicherry University.

7. **Teaching and Learning Methods** : Lectures, tutorials and seminars are the main methods of course delivery, which would be supplemented by individual practical work, project work, simulation assignment, seminars and industrial visits.
8. Structure of M.Tech Programme:

8.1 The M.Tech Programmes is of semester pattern with 16 weeks of instruction in a semester.

8.2 The programme of instruction for each stream of specialization will consist of:
   i. Core courses (Compulsory)
   ii. Electives
   iii. Laboratory
   iv. Online course
   v. Internship
   vi. Project work

8.3 Credits will be assigned to the courses based on the following general pattern:
   i. One credit for each lecture period
   ii. One credit for each tutorial period
   iii. One credit for Project literature survey
   iv. Two credits for practical course
   v. Two credits for Online course
   vi. Two credits for Internship
   vii. Twelve credits for Project work
   viii. One teaching period shall be of 60 minutes duration including 10 minutes for discussion and movement.

8.4 Regulations, curriculum and syllabus of the M.Tech programme shall have the approval of Board of Studies and other Boards /Committees / Councils, prescribed by the Pondicherry University. The curriculum should be so drawn up that the minimum number of credits and other requirements for the successful completion of the programme will be as given in Table 1.

Table 1: Curriculum Details of the Programme

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Description</th>
<th>Requirements M.Tech (Full-Time)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Number of Semesters</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Min. No. of credits of the Programme</td>
<td>74</td>
</tr>
<tr>
<td>3</td>
<td>Max. No. of credits of the Programme</td>
<td>74</td>
</tr>
<tr>
<td>4</td>
<td>Min. Cumulative Grade Point Average for pass</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>Min. period of completion of the Programme</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>Max. period for completing the Programme</td>
<td>8</td>
</tr>
<tr>
<td>7</td>
<td>Number of core and elective courses</td>
<td>18</td>
</tr>
<tr>
<td>8</td>
<td>Online course</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>Project work (semesters)</td>
<td>2</td>
</tr>
<tr>
<td>11</td>
<td>Internship</td>
<td>1</td>
</tr>
</tbody>
</table>
8.5 A core course is a course that a student admitted to the M.Tech programme must successfully complete to receive the degree. A student must register for all the core courses listed in the curriculum.

8.6 Elective courses are required to be chosen from the courses offered by the department(s) in that particular semester from among the approved courses. A core course of one department may be chosen as an elective by a student from other department ***.

***Note: A candidate should successfully complete 7 electives for the award of degree. However, it is mandatory that the electives for each semester should be from the group of electives listed in curriculum.

8.7 Project work is envisaged to train a student to analyze independently any problem posed to him/her. The work may be analytical, experimental, design or a combination of both. The project report is expected to exhibit clarity of thought and expression.

8.8 The medium of instruction, examination, seminar and project work will be in English.

9. **Requirements to appear for University Examination**: 9.1 A candidate shall be permitted to appear for university examinations at the end of any semester only if he / she secures not less than 75% overall attendance arrived at by taking into account the total number of periods in all subjects put together offered by the institution for the semester under consideration. Candidates who secure overall attendance greater than 60% and less than 75% have to pay a condonation fee as prescribed by the University along with a medical certificate obtained from a medical officer not below the rank of Assistant Director to become eligible to appear for the examinations.

9.2 His / Her conduct should be satisfactory as certified by the Head of the institution.

10. **Evaluation**: 10.1 Theory Courses: 40% of marks for internal and 60% for end semester examinations.

    The end semester question paper will have Part A (6 × 2 = 12 Marks) consisting of six two mark questions and Part B (4 × 12 = 48 Marks) consisting of six twelve mark descriptive questions of which one of them is compulsory and totally a candidate has to answer four out of six. For the end semester examination (University Semester Examination), the questions will be chosen only from the first four units of every theory subject of the programme to account end semester marks of 60 and internally (cumulatively) to assess a candidate’s depth of knowledge in the concerned subject for 40 marks, a minimum of two internal tests (30 marks) shall be conducted. Further, the content of the fifth unit in each subject shall be considered to conduct seminars, tutorials, simulations, assignments, development of hardware models etc. for 10 marks as it is formulated at system level for all subjects of the programme. The question paper setter will be appointed by the Competent Authority of the University. However, the evaluation shall be a central evaluation that shall be carried out by Controller of Examinations, Pondicherry University.
10.2 Practical Courses: 50% of marks for internal and 50% for the end semester examinations.

10.3 Internship/ Seminar/ Workshop / Conference / FDP / Short term course / NPTEL/GIAN/MOOC Course: 100% of marks through internal assessment only.

It is optional to undergo internship in established industry or esteemed institution / Seminar/ Workshop / Conference / FDP / Short term course / NPTEL/GIAN/MOOC Course for a period of four weeks (20 working days) either in single or multiple spans by a candidate. Further, a presentation should be given regarding the training or programme underwent during the period with the submission of a report. There shall not be any end semester evaluation. However, the internal evaluation is done by the committee comprising of internal members and one external member from other department of the same institute constituted by Head of the Department for the award of appropriate grade to the candidate based on the performance. The distribution of marks will be decided by the committee. The internship / Seminar/ Workshop / Conference / FDP / Short term course / NPTEL/GIAN/MOOC Course can be completed at any period of the duration of M.Tech. programme to fulfill the partial requirements for the award of M.Tech. degree.

10.4 NPTEL/GIAN/MOOC Course:

It is mandatory to undergo one course related to the chosen programme for the minimum period of 30 hours either from NPTEL or GIAN or MOOC that is to be completed at any period of the duration of M.Tech. programme to fulfill the partial requirements for the award of M.Tech. degree. Absolute grade shall be awarded to a candidate based on the marks given in the certificate issued by the competent authority (NPTEL or GIAN or MOOC) for the chosen course.

10.5 Project - Literature Survey:

100% of marks through internal assessment only. It is mandatory to undergo a complete literature survey by a candidate on the area of project work in the third semester regularly. There will be two reviews for the candidate on the literature survey carried out. There shall not be any end semester evaluation. However, the internal evaluation is based on the presentation of the candidate with the submission of a report about the literature survey. It will be done by the committee comprising of internal members and one external member from other department of the same institute constituted by Head of the Department for the award of appropriate grade to the candidate based on the performance. The distribution of marks for the literature survey will be decided by the committee.

10.6 Project and Viva Voce: 50% of marks for internal and 50% for end semester examinations.

The Project work shall be evaluated for a maximum of 100 marks. There shall be three assessments during the fourth semester by a review committee. The Head of the Department shall constitute the review committee consisting of supervisor, project coordinator and
another faculty member from the Department for the internal assessment (30 marks). The contribution by the respective supervisor of a student for 20 marks shall be accounted for the internal marks of 50. The end semester Project Viva Voce (for 50 marks) shall be conducted by the external member nominated by the competent Authority of the University. The distribution of the marks is shown in the Table given below.

### Table 2: Allocation of marks

<table>
<thead>
<tr>
<th>Internal (50 Marks)</th>
<th>External (50 Marks)</th>
<th>Total (100 Marks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Review Committee (30 Marks)</td>
<td>Supervisor (20 Marks)</td>
<td></td>
</tr>
<tr>
<td>First Review 10 Marks</td>
<td>Second Review 10 Marks</td>
<td>Third Review 20 Marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10.7 Publication: Mandatory requirement for the completion of the programme.

It is mandatory to have a minimum of one submitted manuscript / accepted publication in reputed journal during the M.Tech. programme. However, the submitted manuscript / accepted paper is subject to the recommendation of the evaluating committee comprising of internal members from same Department constituted by Head of the Department and one external member (examiner) from other institute nominated by competent Authority of University for the acceptance of the quality of the manuscript /paper of the candidate. The publication can be made at any period of the duration of M.Tech. programme. However, it does not contribute any credits to the programme but mandatory to fulfill the partial requirements for the award of M.Tech. degree. This evaluation process may be carried out along with even end semester examination depending up on the status of the students.

10.8 The end-semester examination shall be conducted by the Pondicherry University for all the courses offered by the department. A model question paper, as approved by the Chairperson, BOS (ECE), Pondicherry University, for each course offered under the curriculum should be submitted to the University.

10.9 The University shall adopt the double valuation procedure for evaluating the end-semester examinations, grading and publication of the results. Each answer script shall be evaluated by two experts. If the difference between the total marks awarded by the two examiners is not more than 15% of end-semester examination maximum marks, then the average of the total marks awarded by the two examiners will be reckoned as the mark secured by the candidate; otherwise, a third examiner is to be invited to evaluate the answer scripts and his/her assessment shall be declared final.

10.10 Continuous assessment of students for theory courses shall be based on two tests (15 marks each) and one assignment (10 marks). A laboratory course carries an internal assessment mark of 50 distributed as follows: (i) Regular laboratory exercises and records –
20 marks (ii) Internal laboratory test– 20 marks and (iii) Internal viva-voce – 10 marks.

10.11 All eligible students shall appear for the University examination.

11. Grading

11.1 The assessment of a course will be done on absolute marks basis. However, for the purpose of reporting the performance of a candidate, letter grades, each carrying stipulated points, will be awarded as per the range of total marks (out of 100) obtained by the candidate, as detailed below in Table 3.

Table 3: Letter Grade and the Corresponding Grade Point

<table>
<thead>
<tr>
<th>Range of Total Marks</th>
<th>Letter Grade</th>
<th>Grade Point</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 to 100</td>
<td>S</td>
<td>10</td>
<td>Excellent</td>
</tr>
<tr>
<td>80 to 89</td>
<td>A</td>
<td>9</td>
<td>Very Good</td>
</tr>
<tr>
<td>70 to 79</td>
<td>B</td>
<td>8</td>
<td>Good</td>
</tr>
<tr>
<td>60 to 69</td>
<td>C</td>
<td>7</td>
<td>Above Average</td>
</tr>
<tr>
<td>55 to 59</td>
<td>D</td>
<td>6</td>
<td>Average</td>
</tr>
<tr>
<td>50 to 54</td>
<td>E</td>
<td>5</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>0 to 49</td>
<td>F</td>
<td>0</td>
<td>Failure</td>
</tr>
<tr>
<td>-</td>
<td>FA</td>
<td>-</td>
<td>Failure due to lack of attendance</td>
</tr>
<tr>
<td>-</td>
<td>AB</td>
<td>-</td>
<td>Failure by absence</td>
</tr>
</tbody>
</table>

11.2 A student is deemed to have completed a course successfully and earned the appropriate credit if and only if, he /she receives a grade of E or above. The student should obtain 40% of marks in the University examination in a subject to earn a successful grade. A candidate shall be declared to have passed the examination in a subject of study only if he/she secures not less than 50% of the total marks (Internal assessment plus university examination marks).

11.3 A candidate who has been declared “Failed” in a course may reappear for that subject during the subsequent semester and secure a pass.

11.4 The internal assessment marks secured by a student in a theory course shall be considered only during the first appearance. For the subsequent attempts, the marks secured by the student in the University examination shall be scaled up to the total marks. Further, the marks secured by the student in the University examination in the latest attempt shall alone remain valid in total suppression of the University examination marks secured by the student in earlier attempts.
12. Declaration of Results, Rank and Issue of Grade Card

12.1 The results will be declared and the grade cards will be issued to the students after completing the valuation process.

12.2 The grade cards will contain the following details:

i. The college in which the candidate is studying/has studied.

ii. The list of courses enrolled during the semester and the grades scored.

iii. The Grade Point Average (GPA) for the semester and the Cumulative Grade Point Average (CGPA) of all enrolled subjects from first semester onwards.

12.3 GPA is the ratio of the sum of the products of the number of Credits (C) of courses registered and the corresponding Grade Point (GP) scored in those courses, taken for all the courses and the sum of number of credits of all the courses

\[
GPA = \frac{\text{Sum of } (C \times GP)}{\text{Sum of } C}
\]

The sum will cover all the courses the student has taken in that semester, including those in which he/she has secured F.

12.4 CGPA will be calculated in a similar manner, considering all the courses enrolled from first semester. FA grades are to be excluded for calculating GPA and CGPA. If a student has passed in a course after failing in earlier attempts, the grade secured by the student in the successful attempt only will be taken into account for computing CGPA.

12.5 To convert CGPA into percentage marks, the following formula shall be used:

\[
\% \text{ Mark} = (CGPA - 0.5) \times 10
\]

12.6 A candidate who satisfies the course requirements for all semesters and passes all the examinations prescribed for all the four semesters within a maximum period of eight (8) semesters reckoned from the commencement of the first semester to which the candidate was admitted, shall be declared to have qualified for the award of degree.

12.7 A candidate who qualifies for the award of the degree shall be declared to have passed the examination in FIRST CLASS with DISTINCTION upon fulfilling the following requirements:

i. Should have passed all the subjects pertaining to semesters 1 to 4 in his/her first appearance in 4 consecutive semesters starting from first semester to which the candidate was admitted.

ii. Should not have been prevented from writing examinations due to lack of attendance.

iii. Should have secured a CGPA of 8.50 and above from semesters 1 to 4.

12.8 A candidate who qualifies for the award of the degree by passing all the subjects relating to semesters 1 to 4 and secure
CGPA not less than 6.5 shall be declared to have passed the examination in FIRST CLASS. All other candidates who qualify for the award of degree shall be declared to have passed the examination in SECOND CLASS.

12.9 A student with CGPA less than 5.0 is not eligible for the award of degree.

12.10 For the award of University rank and gold medal, the CGPA secured from 1st to 4th semester should be considered and it is mandatory that the candidate should have passed all the subjects from 1st to 4th semester in the first appearance and he/she should not have been prevented from writing the examination due to lack of attendance and should not have withdrawn from writing the University examinations.

13. Provision for Withdrawal : A candidate may, for valid reasons and on the recommendation of the Head of the Institution, be granted permission by the University to withdraw from writing the entire semester examination as one UNIT. The withdrawal application shall be valid only if it is made earlier than the commencement of the last theory examination pertaining to that semester. Withdrawal shall be permitted only once during the entire programme. Other conditions being satisfactory, candidates who withdraw are also eligible to be awarded DISTINCTION whereas they are not eligible to be awarded a rank/gold medal.

14. Temporary Discontinuation from the Programme : If a candidate wishes to temporarily discontinue the programme for valid reasons, he/she shall apply through the Head of the Institution in advance and obtain a written order from the University permitting discontinuance. A candidate after temporary discontinuance may rejoin the programme only at the commencement of the semester at which he/she discontinued, provided he/she pays the prescribed fees to the University. The total period of completion of the programme reckoned from the commencement of the first semester to which the candidate was admitted shall not in any case exceed 4 years, including the period of discontinuance.

15. Revision of Regulations and Curriculum : The University may from time to time revise, amend or change the regulations of curriculum and syllabus as and when requirement for the same arises.

16. Power to Modify : 16.1 Notwithstanding anything contained in the foregoing, the Pondicherry University shall have the power to issue directions/orders to remove any difficulty.

16.2 Nothing in the foregoing may be construed as limiting the power of the Pondicherry University to amend, modify or repeal any or all of the above.

17. Minimum number of credits to be acquired for successful completion of the programme : 74 (Seventy Four) Credits
### iii) Curriculum for M.Tech. (Electronics and Communication Engineering)

#### I Semester

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Course Code</th>
<th>Name of the Course</th>
<th>H/S</th>
<th>L-T-P</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ECENG 510</td>
<td>Communication and Embedded Systems Laboratory - I</td>
<td>H</td>
<td>0-0-4</td>
<td>2</td>
</tr>
<tr>
<td>2.</td>
<td>ECENG 511</td>
<td>Advanced Digital Communication</td>
<td>H</td>
<td>3-1-0</td>
<td>4</td>
</tr>
<tr>
<td>3.</td>
<td>ECENG 512</td>
<td>Advanced Engineering Mathematics</td>
<td>H</td>
<td>3-1-0</td>
<td>4</td>
</tr>
<tr>
<td>4.</td>
<td>ECENG 513</td>
<td>Embedded Systems and VLSI Design</td>
<td>H</td>
<td>3-1-0</td>
<td>4</td>
</tr>
<tr>
<td>5.</td>
<td>ECENG 514</td>
<td>High Speed Semiconductor Devices</td>
<td>H</td>
<td>3-1-0</td>
<td>4</td>
</tr>
<tr>
<td>6.</td>
<td>Elective I</td>
<td></td>
<td>S</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td>Elective II</td>
<td></td>
<td>S</td>
<td>2-1-0</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Credits for Semester I** 24

(H – Hard Core Course; S – Soft Core Course)

#### II Semester

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Course Code</th>
<th>Name of the Course</th>
<th>H/S</th>
<th>L-T-P</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.</td>
<td>ECENG 520</td>
<td>Communication and Embedded Systems Laboratory - II</td>
<td>H</td>
<td>0-0-4</td>
<td>2</td>
</tr>
<tr>
<td>9.</td>
<td>ECENG 521</td>
<td>Advanced Digital System Design</td>
<td>H</td>
<td>3-1-0</td>
<td>4</td>
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**Total Credits for Semester II** 24

(H – Hard Core Course; S – Soft Core Course)
### III Semester

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**Total Credits for Semester III** 14

(H – Hard Core Course; S – Soft Core Course)

### IV Semester

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**Total Credits for Semester IV** 12

(H – Hard Core Course; S – Soft Core Course)

**Total number of credits required to complete**

**M.Tech in Electronics and Communication Engineering**: 74 credits
### Semester I – List of Electives

<table>
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<tr>
<th>Sl. No.</th>
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<td>1.</td>
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<td>Advanced Electromagnetics</td>
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<td>2.</td>
<td>ECENG 531</td>
<td>Advanced Image Processing</td>
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<td>ECENG 532</td>
<td>Advanced Information Theory and Coding Techniques</td>
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<td>ECENG 533</td>
<td>Advanced Microcontroller and its Applications</td>
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<td>Advanced Optical Communication</td>
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<td>Advanced Satellite Communication</td>
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<td>ECENG 536</td>
<td>Low Power Digital VLSI Design</td>
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<td>8.</td>
<td>ECENG 537</td>
<td>Micro and Nano Electronic Engineering</td>
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<td>9.</td>
<td>ECENG 538</td>
<td>Microwave Circuits</td>
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<td>ECENG 539</td>
<td>Mobile Communication System</td>
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### Semester II - List of Electives

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<td>1.</td>
<td>ECENG 550</td>
<td>Advanced Radiation Systems</td>
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<td>2.</td>
<td>ECENG 551</td>
<td>Design of Analog and Mixed VLSI Circuits</td>
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<td>ECENG 552</td>
<td>Electromagnetic Interference and Compatibility</td>
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<td>ECENG 553</td>
<td>High Performance Communication Networks</td>
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<td>ECENG 554</td>
<td>Industrial Electronics</td>
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<td>Information and Network Security</td>
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<td>ECENG 556</td>
<td>Modeling and Simulation of Wireless Communication Systems</td>
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<td>ECENG 557</td>
<td>Pattern Recognition and Artificial Intelligence</td>
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<td>RF Micro-Electromechanical Systems</td>
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<td>Advanced Technologies in Wireless Networks</td>
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<td>Cognitive Radio Technology</td>
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<td>Convergence Technologies</td>
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<td>Carbon Nanotubes Devices and Applications</td>
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<td>Free Space Optical Networks</td>
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<td>Internet of Every Things (IoET)</td>
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<td>Principles of ASIC Design</td>
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<td>Soft Computing</td>
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<td>Vehicular Ad-hoc Networks (VANET)</td>
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iv) Syllabus for M.Tech. (Electronics and Communication Engineering):

<table>
<thead>
<tr>
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<th>Credits</th>
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<tr>
<td>ECENG 510</td>
<td>COMMUNICATION AND EMBEDDED SYSTEMS LABORATORY - I</td>
<td>L</td>
<td>T</td>
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</table>

Objective: Hands on experience on hardware experiments in order to acquire sufficient knowledge and understand practical nuances of various communication techniques.

LIST OF EXPERIMENTS (Given the list is minimal, however, the course teacher can decide the level of experiments)

1. Microcontroller Based Experiments
   a. Various Logic Operations
   b. Level and Edge Triggering Interrupts
   c. ADC/DAC
   d. Real time digital clock and alarm realization

2. DSP Based Experiments
   a. Wave form generation
   b. Linear and Circular convolution
   c. FIR filter implementation
   d. IIR filter implementation

3. Communication Based Experiments
   a. Design and analysis of GMSK modulator and demodulator
   b. Data transmission, Multiplexing and BER measurement through optical fiber
   c. Characterization of Directional Coupler and Power Divider using microstrip trainer kit
   d. Measurement of radiation pattern of microstrip patch antenna
   e. Study of DPCM and ADPCM using Advanced Digital Modulator trainer kit

4. VLSI Based Experiments
   a. Synthesis of 8-bit adders
   b. Synthesis of 4-bit multiplier
   c. Synthesis of mod-13 counter
   d. Synthesis of FSM

ECENG 510
<table>
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<td>ECENG 511</td>
<td>ADVANCED DIGITAL COMMUNICATION</td>
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**Prerequisite:** Basics of analog and digital communication systems.

**Objective:** To make the students to understand the various advanced concepts of digital communication techniques.

**Outcome:** Students will be able to imply the concepts of advanced digital communication techniques to various applications.

**Unit I: Digital Modulation Techniques**  
12 Hours

Elements of Digital Communication system - Factors influencing digital modulation techniques; Linear Modulation Techniques: BPSK - QPSK - DPSK; Constant envelope modulation techniques: MSK- GMSK; Linear and constant envelope modulation techniques: M- ary PSK and M- ary QAM.

**Unit II: Additive White Gaussian Noise Channel**  
12 Hours

Optimum receiver for signals corrupted by AWGN - performance of the optimum receiver for memory less modulation; optimum receiver for CPM signals - optimum receiver for signals with random phase in AWGN channel.

**Unit III: Equalization Techniques**  
12 Hours


**Unit IV: Synchronization**  
12 Hours


**Unit V: Instructional Activities**  
12 Hours

Simulation: Different digital modulation - AWGN channel - equalization techniques and synchronization using any related platforms.
**Reference Books:**


**Hyperlinks:**

1. http://nptel.iitm.ac.in/courses/117101051.html
2. http://nptel.ac.in

**ECENG 511**
<table>
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<tr>
<td>ECENG 512</td>
<td>ADVANCED ENGINEERING MATHEMATICS</td>
<td>L T P</td>
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**Prerequisite:** Basics of Engineering Mathematics

**Objective:** To make the students to understand various mathematical concepts implied to electronics and communication engineering.

**Outcome:** The students will be able to apply these mathematical concepts to various applications of electronics and communication engineering.

**Unit I: Random Variables** 12 Hours

Random variables: Probability axioms - conditional probability - discrete and continuous random variables, Cumulative Distribution Function (CDF) - Probability Mass Function (PMF) - Probability Density Function (PDF) - Conditional PMF/PDF - Expected value - Variance; Functions of a random variable; Expected value of the derived random variable.

**Unit II: Multiple Random Variables** 12 Hours

Multiple random variables: Joint CDF/PMF/PDF - functions of multiple random variables - multiple functions of multiple random variables - independent/uncorrelated random variables - sums of random variables - moment generating function - random sums of random variables.

**Unit III: Stochastic Processes** 12 Hours


**Unit IV: Finite Difference Time Domain Method** 12 Hours

Wave Equation: Dispersion and Stability ; The FDTD method: Staggered Grids- one space dimension- three space dimensions-integral interpretation of the FDTD method- dispersion analysis in three Dimensions ; Boundary conditions for open regions: The perfectly matched Layer - near to far field transformation.

**Unit V: Instructional Activities** 12 Hours

Response of LTI system’s - probability distribution and density function - Weiner and Shot noise process- Practical applications of wave scattering in FDTD using related platforms.
Reference Books:

Hyperlinks:
1. http://users.ece.utexas.edu/~gustavo/ee381j.html
2. http://www2.math.uu.se/research/telecom/software.html
3. http://www.ifp.illinois.edu/~hajek/Papers/randomprocesses.html

ECENG 512
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<td>ECENG 513</td>
<td>EMBEDDED SYSTEMS AND VLSI DESIGN</td>
<td>L T P</td>
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**Prerequisite**: Knowledge of digital electronics, microprocessor architecture and assembly language, C programming language

**Objective**: To make the students to understand the basics of embedded system and also the VLSI design using CMOS.

**Outcome**: Students will be aware of principles and design issues of various embedded processors and VLSI circuits.

**Unit I: Embedded System**
12 Hours

**Unit II: Embedded Processors**
12 Hours
Architecture of the Kernel: Preliminaries - PIC Processor - ARM processor - SHARC processor - design methodologies- specifications - architecture design and system analysis.

**Unit III: Digital VLSI Design using CMOS**
12 Hours
Principles of circuit design using pass transistors and transmission gates - combinational logic circuit design - sequential logic circuit design - Flip Flops - synchronous sequential circuits and clocked storage elements.

**Unit IV: Layout Analysis**
12 Hours
Resistive and inductive interconnect delays - network delay - layouts - simulation - switch logic networks - gate and network testing - memory cells and arrays - clocking disciplines - power optimization - validation and testing.

**Unit V: Instructional Activities**
12 Hours
Study on embedded system design: Telephone PBX - ink jet printer - water tank monitoring system- GPRS - Personal Digital Assistants; Simulation of VLSI Circuits: Basic gates using logic families - CMOS inverter layout.
Reference Books:

Hyperlinks:
7. http://ic.sjtu.edu
8. http://nptel.iitm.ac.in

ECENG 513
<table>
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<td>ECENG 514</td>
<td>HIGH SPEED SEMICONDUCTOR DEVICES</td>
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**Prerequisite**: Fundamental knowledge in Semiconductor Devices and Circuits

**Objective**: The course aims to give exposure on the band diagram, structure, characteristics of hetero-junction devices and their fabrication techniques.

**Outcome**: Students will be able to understand the behavior of semiconductor materials and be aware of the structure of advanced devices and their fabrication techniques.

**Unit I: Semiconductor Materials**  12 Hours
Review of Crystal Structure: Crystal structure of important semiconductors (Si, GaAs, InP) - electrons in periodic lattices - energy band diagram - carrier concentration and carrier transport phenomenon - electrical - optical - thermal and high field properties of semiconductors.

**Unit II: Fabrication Techniques**  12 Hours
Crystal Growth and Wafer Preparation- epitaxy - dielectric film deposition and oxidization techniques - masking and lithography techniques (optical, e-beam and other advanced lithography techniques) - diffusion - ion implantation - metallization - bipolar and MOS integration techniques - interface passivation techniques.

**Unit III: MOS Devices**  12 Hours

**Unit IV: High Speed Devices**  12 Hours

**Unit V: Instructional Activities**  12 Hours
Simulation study: MOSFET - HBT /HEMT- FinFET – SET using related tools.
Reference Books:

Hyperlinks:
2. http://nptel.iitm.ac.in/video.php/subjectId/117106093

ECENG 514
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<td>COMMUNICATION AND EMBEDDED SYSTEMS LABORATORY – II</td>
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**Objective:** Hands on experience on various simulation tools to design and analyze the various communication techniques.

**LIST OF EXPERIMENTS:** (Given the list is minimal, however, the course teacher can decide the level of experiments)

1. **Simulation using MATLAB / SCILAB (open source)**
   a. Direct sequence spread spectrum system
   b. Channel coding
   c. Line coding
   d. Filters
   e. Modulation schemes
   f. Security algorithm and authentication protocols

2. **Simulation using VHDL/ Verilog**
   a. Flip Flops
   b. Synchronous/ Asynchronous Counters
   c. Registers
   d. ROM/RAM
   e. PRBS generator

3. **Simulation using PSPICE**
   a. Analog circuits
   b. Digital circuits
   c. Communication circuits

4. **Simulation using NetSim**
   b. Design and analyse the Spanning tree algorithm.
   c. Performance analysis of WiMAX/ WiFi network.
   d. Performance analysis of convergence networks (WiMAX and LTE networks)

ECENG 520
<table>
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<th>Periods</th>
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<td>ECENG 521</td>
<td>ADVANCED DIGITAL SYSTEM DESIGN</td>
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**Prerequisite**: Knowledge on digital integrated circuit design, Verilog and FPGA.

**Objective**: To make the students to understand the design and analysis of the synchronous and asynchronous sequential circuits.

**Outcome**: The students will be able to design sequential circuits and fault diagnosis algorithms.

**Unit I: Sequential Circuit Design**  
12 Hours
Analysis of clocked synchronous sequential circuits and modeling- state diagram - state table - state table assignment and reduction - design of iterative circuits - ASM chart and realization using ASM.

**Unit II: Asynchronous Sequential Circuit Design**  
12 Hours

**Unit III: Synchronous Design Using Programmable Devices**  
12 Hours
Programming logic device families: Designing a synchronous sequential circuit using PLA/PAL - realization of finite state machine using PLD/FPGA.

**Unit IV: Fault Diagnosis And Testability Algorithms**  
12 Hours

**Unit V: Instructional Activities**  
12 Hours
Simulation of synchronous/ asynchronous sequential circuits: Logic compilation - two level and multi level logic synthesis - sequential logic synthesis - technology mapping - tools for mapping to PLDs and FPGAs.
Reference books:


Hyperlinks:


ECENG 521
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<tr>
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<td>ECENG 522</td>
<td>ADVANCED DIGITAL SIGNAL PROCESSING</td>
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</table>

Prerequisite: Knowledge in Signal and Systems, and Digital Signal Processing

Objective: To make the students to understand the concepts in signal processing mechanisms and power spectrum estimation methods

Outcome: Students will be able to analyze and implement advanced signal processing techniques for various applications.

Unit I: Fundamentals of Signal Processing  12 Hours
Introduction: Basic elements of Digital Signal Processing System- advantages of digital over analog signal processing; Classification of signals: Deterministic vs random signals - multi channel and multi-dimensional signals; Down Sampling-decimation-up sampling-interpolation.

Unit II: Power spectrum estimation  12 Hours

Unit III: Adaptive Signal processing  12 Hours
FIR adaptive filters- steepest descent adaptive filter - LMS algorithm - convergence of LMS algorithms; Applications: Noise cancellation - channel equalization; Adaptive recursive filters - recursive least square estimation.

Unit IV: Wavelet Transform  12 Hours
Introduction: Continuous Wavelet Transform - basic properties of wavelet transforms - Discrete Wavelet Transform: Haar scaling functions and function spaces - nested spaces - Haar wavelet function - orthogonality of φ(t) and ψ(t) - normalization of Haar bases at different scales; Daubechies wavelets - support of wavelet system.

Unit V: Instructional Activities  12 Hours
EEG/ECG signal analysis for the real time environment; Echo cancellation using adaptive filters; Voice recognition and speech-to-text conversion using related tools.
**Reference Books:**


**Hyperlink:**

2. [http://ar.book.org/s/?q=DSP+PROAKIS&yearFrom=&yearTo=&language=&extension=&t=0](http://ar.book.org/s/?q=DSP+PROAKIS&yearFrom=&yearTo=&language=&extension=&t=0)

ECENG 522
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<td>ADVANCED WIRELESS COMMUNICATIONS</td>
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**Prerequisite**: Basics of analog, digital and wireless communication.

**Objective**: To impart the new concepts in advanced wireless communications.

**Outcome**: Students will able to understand the latest technologies used in advanced wireless communication systems.

**Unit I: Introduction** 12 Hours
Introduction about wireless communication - technical challenges of wireless communication-applications; Cellular architecture - frequency reuse - channel assignment - handoff - coverage and capacity improvement; Multiple access: FDMA/CDMA/TDMA/SDMA.

**Unit II: Propagation principles** 12 Hours
Propagation principles: Propagation mechanisms - channel modeling methods - radio channels-indoor channels - outdoor channels - fading channels; Mobile Radio Propagation: Large scale path loss - path loss and propagation models - small scale fading - types of small scale fading-parameters of mobile multipath channels - statistical models for multipath fading channels.

**Unit III: Modulation and Detection** 12 Hours
Digital modulation: Structure of a wireless communication link - linear and constant envelope modulation techniques for wireless communication - error performance in fading channel; Transmission System; combined fast and slow fading - equalization - different detection techniques used in wireless communication.

**Unit IV: MIMO Systems** 12 Hours
Types of MIMO Systems: Beam forming - spatial multiplexing - basic space time code design principles- Alamouti scheme - orthogonal and quasi orthogonal space time block codes- space time trellis codes - representation of space - performance analysis for space-time trellis codes - comparison of space-time block and trellis codes.

**Unit V: Instructional Activities** 12 Hours
Simulation of minimum of (two) modulation and multiple access technique for wireless communication using related tools.
Reference Books:

Hyperlinks:
3. https://videoken.com/search-results

ECENG 523
Course Code | Name of the Course | Periods | Credits | Total Hours
--- | --- | --- | --- | ---
ECENG 524 | MODERN COMMUNICATION SYSTEMS | L | T | P | 4 | 60

**Prerequisite**: Basics of analog and digital communication systems and elementary knowledge of wireless communication systems.

**Objective** : To impart the new concepts of different communication systems.

**Outcome** : Students will aware of the principles and techniques used in modern communication systems.

**Unit I: Microwave and Satellite Communication Systems**  **12 Hours**
Microwave communication systems - transmitters - receivers - line of sight propagation; Orbits of satellite - orbital effects on communication system’s performance - satellite earth stations - satellite antennas and earth coverage - system noise temperature and G/T ratio - design of downlinks - uplink design - link design for specified C/N - VSAT systems.

**Unit II: Optical Communication System**  **12 Hours**
Prologue: Historical perspective - light sources - photodiodes - fiber losses - signal dispersion - pulse propagation - multichannel propagation - signal propagation - modulation schemes; OFDM for optical communications - MIMO optical communications - Detection Schemes; Coherent optical OFDM detection - optical MIMO detection.

**Unit III: Cellular Communication System**  **12 Hours**
Uniqueness of mobile radio environment - basic cellular system - analog and digital cellular systems - cell coverage - frequency reuse - channel interferences - cell splitting and handoffs - mobile antennas.

**Unit IV: Cognitive Radio**  **12 Hours**
Overview of cognitive radio- cognitive radio network architecture - functions of cognitive radio - spectrum policies and regulations - spectrum sensing - spectrum analysis - spectrum sharing/management and spectrum mobility - applications of cognitive radio.

**Unit V: Instructional Activities**  **12 Hours**
Performance analysis of minimum of four communication systems through simulation using related platforms.
Reference Books:


Hyperlinks:

1. nptel.ac.in/courses/117104099/
2. nptel.ac.in/courses/117101002/
3. nptel.ac.in/courses/117104127/
4. nptel.ac.in/courses/117105131/
5. nptel.ac.in/courses/117102062/

ECENG 524
Course Code | Name of the Course | Periods | Credits | Total Hours
---|---|---|---|---
ECENG 530 | ADVANCED ELECTROMAGNETICS | L | T | P | 3 | 45

Prerequisite: Basic knowledge of electromagnetic theory.

Objective: To develop the skills required to solve problems related to harmonic electromagnetic fields and momentum methods.

Outcome: The students will be able to analyze EFIE, MFIE for any type of microwave

Unit I: Electromagnetic Waves 9 Hours

Unit II: Theorems and Concepts 9 Hours
Source concept: Duality - uniqueness ; Image Theory: Equivalence principle - fields in half space - the induction theorem - reciprocity - Green’s function - tensor Green’s function - integral equation; Construction of solutions; Radiation fields.

Unit III: Time Varying Harmonic Electromagnetic Fields 9 Hours
Introduction: Maxwell equations - differential and integral form - constitutive parameters and relations - circuit field relations - boundary conditions - sources along boundary - time harmonic electromagnetic fields - Maxwell equations in differential and integral form - power and energy.

Unit IV: Integral Equation in Momentum Method 9 Hours
Introduction: Integral equation method - electro charge distribution - integral equation - radiation pattern - point matching method - basis function - moment method electric and magnetic field integral equations; Finite diameter wires - Pocklington’s integral equation- Hallen’s integral equation.

Unit V: Instructional Activities 9 Hours
Simulation study of Green’s function - Green’s function for Sturm - Green’s function in two dimensions - double series method - single series expansion method - Green’s function in spectral domain - Green’s function for unbounded region.
Reference Books:

Hyperlinks:
1. http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-Guwahati/em

ECENG 530
Course Code | Name of the Course | Periods | Credits | Total Hours
--- | --- | --- | --- | ---
ECENG 531 | ADVANCED IMAGE PROCESSING | L T P | 3 | 45

Prerequisite: Fundamentals of signals and systems

Objective: Make the students to understand the concepts used in image processing techniques and its analysis.

Outcome: Students will be able to work with various image processing techniques for real time applications.

Unit I: Digital Image Fundamentals 9 Hours
Image fundamentals: Image acquisition - sampling and quantization - image resolution - basic relationship between pixels - color images - RGB, HSI and other models; Transform based models (DFT, DCT, DWT); Image Enhancement: Spatial and frequency averaging - smoothening and sharpening filters.

Unit II: Segmentation and Denoising 9 Hours
Image Segmentation: Edge detection - edge linking via Hough transform - thresholding - region based segmentation; Denoising: Maximum likelihood estimation - Bayesian estimators - model selection (MDL principle) - transform based denoising - adaptive wiener filtering - soft shrinkage and hard thresholding.

Unit III: Image Compression 9 Hours
Image compression: Basics of source coding theory (lossless and lossy) - Vector quantization - codebook design - transform and sub band coding.

Unit IV: Image security and forensic 9 Hours
Image Security: cryptography and steganography techniques - Chaos based and Non-Chaos based methods; Image Forensics: Key photographic techniques-detection techniques for crime scene analysis.

Unit V: Instructional Activities 9 Hours
Simulation of preprocessing techniques-implementation of image processing techniques for real time applications-forensic analysis using related tools.
Reference Books:


Hyperlinks:

1. www.imageprocessingplace.com/DIP-3E/dip3e_main_page.html

ECENG 531
**Course Code** | **Name of the Course** | **Periods** | **Credits** | **Total Hours**
--- | --- | --- | --- | ---
ECENG 532 | ADVANCED INFORMATION THEORY AND CODING TECHNIQUES | L | T | P | 3 | 45

**Prerequisite:** Knowledge in probability and calculus.

**Objective:** To understand the concepts of various coding techniques with their applications.

**Outcome:** Students will be able to incorporate the various coding techniques in the field of wireless communications.

**Unit - I : Entropy**

Entropy: Memory less sources - Markov sources - entropy of a discrete random variable - joint conditional and relative entropy - mutual information and conditional mutual information; chain relation for entropy - relative entropy and mutual Information.

**Unit - II: Source Coding Theorems & Gaussian Approach**

Loss less source coding: Uniquely decodable codes - instantaneous codes - Kraft's inequality - optimal codes - Huffman code-Shannon's Source Coding Theorem :Arimoto - Blahut algorithm - Fano's inequality ;Shannon's channel coding theorem and its converse; Mutual information and capacity calculation for band limited Gaussian channels - Shannon limit - parallel Gaussian channels - capacity of channels with colored Gaussian noise.

**Unit - III: Block Codes**

Linear block codes - error detecting and correcting capability – types of Block Codes – Reed Solomon codes - interleaving and concatenated codes - coding and interleaving applied to the compact disc digital audio system - LDPC codes.

**Unit - IV: Convolutional Codes**


**Unit- V: Instructional Activities**

Simulation of minimum of five coding techniques using related tools.
References Books:

Hyperlinks:

ECENG 532
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Name of the Course</th>
<th>Periods</th>
<th>Credits</th>
<th>Total Hours</th>
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</thead>
<tbody>
<tr>
<td>ECENG 533</td>
<td>ADVANCED MICROCONTROLLER AND ITS APPLICATIONS</td>
<td>L 2 T 1 P 0</td>
<td>3</td>
<td>45</td>
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</tbody>
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Prerequisite: Knowledge in microprocessor and microcontrollers architecture

Objective: To gain knowledge in advanced topics related to microcontrollers with interfacing methodologies.

Outcome: The students will be able to apply the gained knowledge from basic 8051 microcontrollers to the advanced RISC processors like ARM, for real-time applications.

Unit I: Introduction to 8051 Microcontroller and its architecture 9 Hours
Introduction to 8051 microcontroller: pin diagram - block diagram - on-chip internal memory (RAM, ROM) - counters - watch dog timer and its applications - instruction set - UART - assembly language programming from simple to interfacing of ADC / DAC - stepper motors - keyboard - sensors - serial data communication.

Unit II: Programming of 8051 in embedded C 9 Hours
Date types in embedded C - arithmetic and logical operators - control statements and loops in embedded C - functions and arrays in embedded C.

Unit III: PIC 18F Family 9 Hours
Introduction to PIC 18F: Architecture - programming model - instruction set - simple programming using data transfer - arithmetic and logical instructions - programming on stack - loop instructions and subroutines - programming on timers and counters.

Unit IV: ARM Architectures 9 Hours
Introduction to ARM: ARM processor fundamentals - ARM instruction set - thumb instruction set - writing and optimizing ARM assembly code - exception and interrupt handling.

Unit V: Instructional Activities 9 Hours
Interfacing of memory and I/O devices with ARM/ PIC using embedded C programming: Keyboard - servo motor - stepper motor - sensors - ADC/DAC - display devices.
Reference Books:

Hyperlink:
4. https://onlinecourses.nptel.ac.in/noc18_ec03/preview

ECENG 533
Prerequisite: Sound knowledge on basic optics, optical communication, various modulation and detection schemes in optical communication.

Objective: To impart the concepts of multilevel modulation schemes, OFDM and MIMO for optical communication systems and nonlinear optics.

Outcome: Students will be able to understand the potential of physical layer of optical system and its applications.

**Unit I: Introduction**

Prologue: Historical perspective - light sources - modulators, fiber losses - signal dispersion - multi channel propagation - optical solutions- photonic crystal and Photonic Band Gap (PBG); Second order nonlinear optics: Second Harmonic Generation (SHG) - Sum Frequency Generation (SFG) - Difference Frequency Generation (DFG); Third order nonlinear optics: Third Harmonic Generation (THG) - Four Wave Mixing (FWM) - Self Focusing (SF).

**Unit II: Modulation schemes**

Noise sources - channel impairments - optical transmission system - advanced modulation formats - multilevel modulation schemes - OFDM for optical communications - MIMO optical communication - polarization multiplexing - constrained (line or modulation) coding - soliton based communication.

**Unit III: Detection schemes**

Coherent detection of optical signals - optical coherent detection schemes - optical heterodyne detection - optical homodyne detection - optical intradyne detection - DPSK photonic systems - optical channel equalization - coherent optical OFDM detection - optical MIMO detection.

**Unit IV: Optical Channel Estimation**

Optical channel capacity - calculation of information capacity - information capacity of systems with direct detection - capacity of optical OFDM systems - capacity of optical MIMO systems.

**Unit V: Instructional Activities**

Simulation of two dimensional photonic crystal, ring resonator and Y-shaped waveguide using 32-bit OPTIFDTD (freeware); Analyze second order nonlinearity and four-wave mixing through simulation using the same FDTD tools.
Reference Books:

Hyperlinks:
1. http://nptel.iitm.ac.in/courses/117101002.html

ECENG 534
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Name of the Course</th>
<th>Periods</th>
<th>Credits</th>
<th>Total Hours</th>
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<tbody>
<tr>
<td>ECENG 535</td>
<td>ADVANCED SATELLITE COMMUNICATION</td>
<td>L T P</td>
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**Prerequisite**: Basics of digital and satellite communication.

**Objective**: To impart the orbital mechanics, space craft sub-systems and satellite link design

**Outcome**: Students will be able to analyze the advanced technical details behind the satellite link.

**Unit I: Introduction and Satellite Access**: 9 Hours
Orbits of Satellite: Low - medium - geo synchronous - angle period - returning period - orbital spacing - delay transponder - earth stations - antennas and earth coverage - altitude and eclipses; Multiple Access: Demand assigned FDMA - spade system - TDMA - satellite switched TDMA - CDMA.

**Unit II: Space Segment and Earth Segment** 9 Hours
Space Segment: Power supply - altitude control - station keeping - thermal control - TT and C subsystem - transponders; Earth Segment: Receive only home TV system - outdoor unit - indoor unit - master antenna TV system - community antenna TV system.

**Unit III: Satellite Link Design** 9 Hours
Link Design: System noise temperature and G/T ratio - C/N design of uplink and downlink - error control for digital satellite link.

**Unit IV: VSAT Systems** 9 Hours
VSAT Systems: Network architectures - access control protocols - earth station engineering - antennas - link margins - system design procedure.

**Unit V: Instructional Activities** 9 Hours
Simulation of link budget for two satellite systems - simulation of transponders and antenna system using related tools.
References Books:


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ECENG 535
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<th>Course Code</th>
<th>Name of the Course</th>
<th>Periods</th>
<th>Credits</th>
<th>Total Hours</th>
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<tr>
<td>ECENG 536</td>
<td>LOW POWER DIGITAL VLSI DESIGN</td>
<td>L T P</td>
<td>3</td>
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Prerequisite: Fundamentals of VLSI design.

Objective: To discuss low power design methodologies at various design levels from the circuit level to the system level and also power estimation with optimization techniques.

Outcome: Students will be able to design low power VLSI circuits.

Unit I: Power Dissipation 9 Hours

Introduction: Need for low power circuit design - sources of power consumption - design methodology - low power figure of merits - limits and applications of low power VLSI Design.

Unit II: Power Analysis 9 Hours

Power Analysis: SPICE circuit simulation - discrete transistor modeling and analysis - gate level logic simulation - architecture level analysis - data correlation analysis; Probabilistic Power Analysis: Random logic signals - probabilistic power analysis techniques - signal entropy.

Unit III: Circuit and Logic Level 9 Hours

Circuit Level: Transistor and gate sizing - equivalent pin ordering - network restructuring and reorganization - special latches and flip flops; Logic level: Gate reorganization - signal gating - logic encoding - precomputation logic.

Unit IV: Energy Recovery Techniques 9 Hours

Energy recovery techniques: Energy dissipation using the RC model - energy recovery circuit design - power reduction in clock networks - low power bus - delay balancing.

Unit V: Instructional Activities 9 Hours

Simulation study: Sources of power dissipation in SRAMs - low power SRAM circuit techniques; Sources of power dissipation in DRAMs - low power DRAM circuit techniques using related tools.
Reference Books:

Hyperlinks:
1. http://www.nptel.iitm.ac.in/courses/106105034/

ECENG 536
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<th>Course Code</th>
<th>Name of the Course</th>
<th>Periods</th>
<th>Credits</th>
<th>Total Hours</th>
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<tbody>
<tr>
<td>ECENG 537</td>
<td>MICRO AND NANO ELECTRONICS ENGINEERING</td>
<td>L T P</td>
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<td>45</td>
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**Prerequisite**: Knowledge in basic sensors, actuators and various fabrication techniques.

**Objective**: To teach the principles in respect of micro and nano electronics, and MEMS/NEMS.

**Outcome**: The students will come out with a complete knowledge of micro and nano fabrication concepts, micro and nano sensors. MEMS/NEMS for real-time application.

**Unit I: MEMS 9 Hours**
Introduction: Need for miniaturization technology - from perception to realization - overall MEMS market size - MEMS market character – Silicon MEMS - non-Silicon MEMS - MEMS versus traditional precision engineering.

**Unit II: Micro Sensors and Actuators 9 Hours**
Sensing and actuation - case studies of real devices; Sensing mechanisms: piezoelectric - piezoresistive - capacitive; Actuation mechanisms: piezoelectric - electrostatic - magnetic and thermal; Physical sensors - opto - fluids - sensors for turbulence measurement and control - micro - actuators for flow control.

**Unit III: Nanomaterials and Nanodevices 9 Hours**
Introduction to nanomaterials : properties of nanomaterials - role of size in nanomaterials and nanoparticles - semiconducting nanoparticles; Nanowires - nanoclusters - quantum wells - conductivity - Carbon Nanotube (CNT): structure of CNT and its properties; Nanosensors-structure- applications

**Unit IV: Micro and Nano Fabrication Techniques 9 Hours**
Introduction to Lithography: Pattern transfer with different techniques - E beam lithography; Micromachining: Size effect in micromachining - mechanical micromachining; Oxidation - CVD of nanostructures - CVD diamond technology for NEMS and MEMS applications - nano crystals - nanowires - nanolithography - etching techniques.

**Unit V: Instructional Activities 9 Hours**
Simulation of minimum of five MEMS/ NEMS using related tools.
Reference Books:


Hyperlinks:


ECENG 537
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<th>Periods</th>
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<th>Total Hours</th>
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<tr>
<td>ECENG 538</td>
<td>MICROWAVES CIRCUITS</td>
<td>L 2 T 1 P 0</td>
<td>3</td>
<td>45</td>
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**Prerequisite** : Knowledge in electromagnetic waves, transmission lines and circuit

**Objective** : To make the students to have a clear knowledge about different concepts of microwave circuits.

**Outcome** : Students will be aware of different microwave circuits’ and their working principles.

**Unit I: Introduction**  
9 Hours
Two port network characterization: Scattering matrix representation of microwave components - maximum power transfer theorem; Transmission lines: Need - quarter wave transformer - smith chart.

**Unit II: Planar Transmission lines**  
9 Hours
Strip line - microstrip line - coplanar waveguide - coplanar strips - slot line - Fin line and characteristics - properties - design parameters and its applications

**Unit III: Microstrip Components**  
9 Hours
3dB hybrid design - backward directional coupler - hybrid ring and power dividers - MIC filters - Kuroda transformation - K inverter - J inverter - resonator filters - realization using microstrip lines.

**Unit IV: Substrate Integrated Waveguide**  
9 Hours
Substrate Integrated Waveguide: Substrate integrated waveguide technology - design of SIW - losses in SIW - SIW circuits composed of metallic posts - SIW circuits with dielectric posts.

**Unit V: Instructional Activities**  
9 Hours
Simulation of (minimum of four) two port networks using various microwave circuits with the help of related tools; Assignments on applications of microwave circuits: space-defense/wireless.
Reference Books:

Hyperlinks:
1. http://nptel.iitm.ac.in/syllabus/117105029/
4. ieeexplore.ieee.org/document/7546658/
5. journal.utom.edu.my/index.php/jtec/article/view/836
6. downloads.hindawi.com/journals/ijap/2013/746920.pdf

ECENG 538
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<thead>
<tr>
<th>Course Code</th>
<th>Name of the Course</th>
<th>Periods</th>
<th>Credits</th>
<th>Total Hours</th>
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</thead>
<tbody>
<tr>
<td>ECENG 539</td>
<td>MOBILE COMMUNICATION SYSTEM</td>
<td>L T P</td>
<td>3</td>
<td>45</td>
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Prerequisite: Fundamentals of analog and digital communication systems.

Objective: To learn the architecture and working principles of mobile communication systems.

Outcome: The students will be able to understand the design principles and techniques of mobile communication systems.

Unit I: Introduction to cellular concepts 9 Hours
Evolution of mobile radio communication - trends in cellular radio and personal communication; Basics of cellular concepts - types and components of mobile communication - operation of cellular system - handoff - radio channel characterization - multiple access schemes.

Unit II: Mobile standards 9 Hours

Unit III: Diversity Schemes 9 Hours
Realization of independent fading paths - Receiver diversity - selection combing - Threshold combing - maximal - ratio combing - equal - gain combing; Transmitter Diversity - channel known at transmitter - channel unknown at transmitter - transmit and receive diversity for MIMO systems.

Unit IV: Mobile IP network and transport layer 9 Hours

Unit V: Instructional Activities 9 Hours
Simulation study of any (five) mobile communication standards using related tools.
References Books:

Hyperlinks:
2. https://www.digitaltrends.com/mobile/4g-vs-lte

ECENG 539
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Name of the Course</th>
<th>Periods</th>
<th>Credits</th>
<th>Total Hours</th>
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<tbody>
<tr>
<td>ECENG 550</td>
<td>ADVANCED RADIATION SYSTEMS</td>
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<td>T 1</td>
<td>P 0</td>
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**Prerequisite**: Electromagnetics and antenna theory.

**Objective**: To learn the antenna radiation concepts, different types of antenna and their design methodology.

**Outcome**: Students will be able to design different types of antenna for various applications.

**Unit I: Concepts of Radiation and Antenna Fundamentals**  
9 Hours
Physical concept of Radiation: Radiation from surface and line current distributions - fundamental parameters of antennas - Friss Transmission Equation - radiation integrals and auxiliary potential functions - Near and Far Field regions - Reciprocity and reaction theorems - radiation hazards and solutions

**Unit II: Aperture and Reflector Antennas**  
9 Hours
Huygens’s principle - radiation from rectangular and circular apertures - design considerations - Babinet’s principle - radiation from sectoral - pyramidal - conical and corrugated Horns - design concepts of parabolic reflectors and cassegrain antennas.

**Unit III: Broadband Antennas**  
9 Hours

**Unit IV: Microstrip Antennas**  
9 Hours
Microstrip Antennas: Radiation mechanism - parameters and applications - feeding methods - design of rectangular and circular patch - impedance matching of microstrip antennas - broadband - compact and tunable microstrip antennas.

**Unit V: Instructional Activities**  
9 Hours
Design, simulation and analysis of different antennas for wireless applications using related simulation tools.
Reference Books:

Hyperlinks:
1. http://www.nptel.ac.in/courses/117107035/
2. http://www.nptel.ac.in/courses/108101092/
3. http://www.nptel.ac.in/courses/108104099/
4. http://www.nptel.ac.in/courses/108104087/

ECENG 550
<table>
<thead>
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<th>Course Code</th>
<th>Name of the Course</th>
<th>Periods</th>
<th>Credits</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECENG 551</td>
<td>DESIGN OF ANALOG AND MIXED VLSI CIRCUITS</td>
<td>L  T  P</td>
<td>3</td>
<td>45</td>
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**Prerequisite**: Basics of semiconductor device operation and VLSI design.

**Objective**: To study analog integrated circuits features design and analysis methods of analog and mixed mode VLSI circuits.

**Outcome**: Students will be able to design efficient analog and mixed mode VLSI circuits.

**Unit I: Data Converters**
9 Hours
Data converter fundamentals: Analog versus digital discrete time signals - converting analog signals to data signals - sample and hold characteristics - DAC specifications - ADC specifications - mixed-signal layout issues.

**Unit II: Data Converter Architectures**
9 Hours
Data converter architectures: DAC architectures - digital input code - resistors string - R-2R ladder networks - current steering - charge scaling - DACs - cyclic DAC - pipeline DAC - ADC architectures - flash ADC - 2-step flash ADC - pipeline ADC - integrating ADC - successive approximation ADC.

**Unit III: SNR in Data Converters**
9 Hours
Data Converter SNR: Improving SNR using averaging (Excluding Jitter & averaging onwards) - decimating filters for ADCs (Excluding Decimating without Averaging onwards) - interpolating filters for DAC - band pass and high pass sync. filters.

**Unit IV: Operational Amplifiers and Mixed Signal Circuits**
9 Hours

**Unit V: Instructional Activities**
9 Hours
Design and simulation of different VLSI Circuits using CAD Tools: Current mirrors - Differential Amplifier - PLL - ADC/DAC
Reference Books:

Hyperlink:
1. http://nptel.ac.in/courses/117101105/
2. http://nptel.ac.in/courses/117101106/
3. http://nptel.ac.in/courses/117106034/
4. http://nptel.ac.in/courses/117106030/

ECENG 551
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Name of the Course</th>
<th>Periods</th>
<th>Credits</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECENG 552</td>
<td>ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY</td>
<td>L T P</td>
<td>3</td>
<td>45</td>
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</table>

Prerequisite: Electromagnetic theory.

Objective: To expose the students on the fundamentals of electromagnetic interference and compatibility in the electronic system design.

Outcome: Students will able to know the EMI environment, coupling principles, specifications, standards and limits, measurements and control techniques, and EMC design of PCBs.

Unit I: EMI Environment 9 Hours
EMI/EMC concepts and definitions: Sources of EMI - conducted and radiated EMI- transient EMI - time domain vs frequency domain EMI - units of measurement parameters.

Unit II: EMI Coupling Principles and Standards 9 Hours
Principles: Conducted, radiated and transient coupling - common impedance ground coupling - radiated common mode and ground loop coupling - radiated differential mode coupling - Near and Far Field cable to cable coupling - power mains and power supply coupling - units of specifications; Civilian Standards: FCC, CISPR 22/CISPR 11 – IEC-61000 -4-2,3,4,5,6,8,11 -EN; Military Standards: MIL STD461D/ 462.

Unit III: EMI Measurements 9 Hours
EMI test instruments/ systems: EMI shielded chamber - open area test site - TEM cell - sensors/ Injectors/ Couplers - test beds for ESD and EFT.

Unit IV: EMI Control Techniques 9 Hours

Unit V: Instructional Activities 9 Hours
Simulation of minimum of (two) EMI coupling methods and controlling techniques with their performance analysis using related tools.
Reference Books:


Hyperlinks:


ECENG 552
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Name of the Course</th>
<th>Periods</th>
<th>Credits</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECENG 553</td>
<td>HIGH PERFORMANCE COMMUNICATION NETWORKS</td>
<td>L</td>
<td>T</td>
<td>P</td>
</tr>
</tbody>
</table>

**Prerequisite:** Fundamentals of computer networks and wireless networks.

**Objective:** To learn the architecture and uniqueness of high performance networks.

**Outcome:** Students will be able to understand the various topologies, services offered by broadband, WiFi, WiMAX, UWB and LTE networks.

**Unit I: Introduction**  
9 Hours

**Unit II: MANET**  
9 Hours
Multihop wireless broadband networks - mesh networks; MANET architecture - classification of routing protocols in MANET - routing metrics; packet scheduling algorithms - power control mechanism.

**Unit III: Internet and TCP / IP Networks**  
9 Hours
Internet Protocol (IP): Technology trends in IP networks - IP packet communications in mobile communication networks; TCP and UDP - performance of TCP / IP networks; Circuit switched networks: SONET- DWDM - fiber to the home - DSL; Intelligent Network (IN) scheme - comparison with conventional systems - merits of the IN scheme; CATV and layered network - services over CATV.

**Unit IV: Enabling Networks**  
9 Hours
WiFi: overview - architecture - PHY and MAC layer; WiMAX overview - system architecture - frame structure - PMP mode - mesh mode - multihop relay mode; UWB overview - time hopping UWB - direct sequence UWB - multiband UWB; LTE and LTE- A overview - system model - frame structure - comparison with broadband technologies.

**Unit V: Instructional Activities**  
9 Hours
Reference Books:

Hyperlinks:

ECENG 553
Course Code | Name of the Course         | Periods | Credits | Total Hours |
-------------|--------------------------|---------|---------|-------------
ECENG 554    | INDUSTRIAL ELECTRONICS   | L T P   | 3       | 45          |

Prerequisite: Knowledge in semiconductor devices and circuits with different analysis.

Objective: To familiarize the latest techniques in industrial electronics from fundamentals to applications.

Outcome: The students will be able to design electronic devices for industrial applications.

Unit I: Semiconductor Devices 9 Hours
Semiconductor devices: Diode - application of diode as switch - Zener diode as regulator - Light Emitting Diode - photo diode; Thyristors: Operation and characteristics of SCR; TRIAC - DIAC - UJT - BJT - MOSFET - Insulated Gate Bipolar Junction Transistor (IGBT) - Operational Amplifiers (IC 741) - IC 555 Timer - Operational modes of IC 555- piezoelectric devices-transducers.

Unit II: Phase controlled Rectifiers and Bridges 9 Hours
Single phase bridge rectifier with R - RL and RLE load - three phase semi converter - three phase full converter - dual converter - harmonic issues in controlled rectifiers; Inverters: Single phase bridge inverter - three phase bridge inverter - 120 and 180 degree mode of operation - voltage and frequency control in inverters.

Unit III: DC-DC converters 9 Hours
DC - DC conversion - Buck Boost converters - circuit configuration and analysis with different types of loads - Resonant DC – DC converters; Switched Mode Power Supply (SMPS) - Concept of PWM in converters - unity power factor converters - Voltage Source Inverters (VSI) - Current Source Inverters (CSI) - Application of VSI and CSI in induction motor control - Uninterrupted Power Supply (UPS).

Unit IV: Digital Design 9 Hours
Logic gates and related IC's - combinational and sequential circuits and their IC's - 8086 Microprocessor - 8051 Microcontroller - interfacing of microprocessor and microcontroller with ADC and DAC - display modules - stepper motors and serial ports - application of microprocessors, microcontrollers and DSP in machine drives.

Unit V: Instructional Activities 9 Hours
Case study in Programmable Logic Controllers (PLC) - PLC programming methodologies - PLC functions - industrial automation using PLC programming.
Reference Books:


Hyperlink:


ECENG 554
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Name of the Course</th>
<th>Periods</th>
<th>Credits</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECENG 555</td>
<td>INFORMATION AND NETWORK SECURITY</td>
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<td>3</td>
<td>45</td>
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</table>

**Prerequisite**: Analog and digital communication

**Objective**: To study the various security attacks- data security and network security algorithms and wireless security mechanism.

**Outcome**: Students will understand the various symmetric and asymmetric cryptographic techniques- authentication mechanism and network security.

**Unit I: Introduction to Cryptography**

9 Hours

Security issues: Security problems in computing - attacks - security services - security mechanism - OSI security architecture - standard setting organizations; Need for cryptographic techniques- substitution - transposition - block ciphers

**Unit II: Data Security and Authentication**

9 Hours

Triple DES with two keys - stream cipher - RC4 - RSA algorithm - elliptical curve cryptography algorithm; MD5 - HASH algorithm - SHA 512 logic - Digital Signatures standards.

**Unit III: Network Security**

9 Hours


**Unit IV: System Security**

9 Hours

Intruders and intrusion detection: Malicious software - viruses and related threats - virus counter measures - distributed denial of service attack - firewalls design principles- trusted systems.

**Unit V: Instructional Activities**

9 Hours

Simulation of minimum of (three) public key and private key cryptography algorithms using related tools.
References Books:


Hyperlinks:

1. https://www.cl.cam.ac.uk/teaching/1314/InfoTheory

ECENG 555
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Name of the Course</th>
<th>Periods</th>
<th>Credits</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECENG 556</td>
<td>MODELING AND SIMULATION OF WIRELESS COMMUNICATION SYSTEMS</td>
<td>L2 T1 P0</td>
<td>3</td>
<td>45</td>
</tr>
</tbody>
</table>

**Prerequisite**: Knowledge of MATLAB programming, digital signal processing and digital communication

**Objective**: To understand the modeling of wireless communication systems through simulation.

**Outcome**: Students will able to design and analyse the various concept of wireless communication systems.

**Unit I: Introduction**  
9 Hours

**Unit II: Generating and Processing Random Signals**  
9 Hours
Stationary and Ergodic Processes: Uniform random number generators - mapping uniform random variables to an arbitrary PDF - generating uncorrelated and correlated Gaussian random numbers - PN sequence generators; Establishing a PDF and PSD Post Processing: Basic graphical techniques - estimation - coding.

**Unit III: Methodology for Simulating a Wireless System**  
9 Hours
Fundamental Concepts of Monte Carlo Simulation - applications and integration - two Monte Carlo examples; Semi Analytic Techniques System: Level simplifications and sampling rate considerations - overall methodology; Modeling and simulation of nonlinearities: Modeling and simulation of memory less nonlinearities - modeling and simulation of nonlinearities with memory - techniques for solving nonlinear differential equations.

**Unit IV: Modeling and Simulation of Time-Varying Systems**  
9 Hours
Introduction: Models for LTV systems - random process models - simulation models for LTV systems; Wired and guided wave - radio channels - multipath fading channels - random process models - simulation methodology; Discrete channel models: Discrete memory less channel models - Markov models for discrete channels with memory- HMMs - Gilbert and Fritchman models - estimation of Markov model parameters.

**Unit V: Instructional Activities**  
9 Hours
Simulation study of generating PDF for the Gaussian and non-Gaussian distributions - linear and nonlinear systems using different techniques with the help of simulation tools.
Reference Books:


Hyperlinks:


ECENG 556
<table>
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<tr>
<th>Course Code</th>
<th>Name of the Course</th>
<th>Periods</th>
<th>Credits</th>
<th>Total Hours</th>
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</thead>
<tbody>
<tr>
<td>ECENG 557</td>
<td>PATTERN RECOGNITION AND ARTIFICIAL INTELLIGENCE</td>
<td>L 2  T 1  P 0</td>
<td>3</td>
<td>45</td>
</tr>
</tbody>
</table>

**Prerequisite**: Basic concepts of probability theory and random process.

**Objective**: To help the students to gain in-depth knowledge in pattern recognition and artificial intelligence.

**Outcome**: Students will be able to apply pattern recognition and artificial intelligence techniques for signal and image processing application.

**Unit I: Introduction to Pattern Recognition**  
Introduction: Probability - statistical decision making - nonparametric decision making - patterns and features - training and learning in pattern recognition - pattern recognition approach - different types of pattern recognition.

**Unit II: Clustering**  
Unsupervised learning: Hierarchical clustering - graph theories approach to pattern clustering - fuzzy pattern classifier - application of pattern recognition in medicine.

**Unit III: Artificial Intelligence**  

**Unit IV: Expert Systems**  

**Unit V: Instructional Activities**  
Range images generation - extraction of geometric elements - automatic scene generation - scene recognition - geometrical hashing using related tools.
Reference Books:


Hyperlinks:


ECENG 557
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Name of the Course</th>
<th>Periods</th>
<th>Credits</th>
<th>Total Hours</th>
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</thead>
<tbody>
<tr>
<td>ECENG 558</td>
<td>RF MICRO-ELECTRO MECHANICAL SYSTEMS</td>
<td>L 2</td>
<td>T 1</td>
<td>P 0</td>
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</table>

**Prerequisite:** Knowledge in design of electronic and microwave circuits

**Objective:** To familiarize the student with the technology and applications of Micro-Electro Mechanical Systems (MEMS).

**Outcome:** Students will be able to design different types of MEMS based devices, circuits and subsystems.

**Unit I: Introduction to MEMS**

9 Hours


**Unit II: Micromachining Technology for MEMS**

9 Hours

Fabrication Process: MEMS fabrication technologies - bulk micro machining - surface micro machining - LIGA process; Bonding and packaging of MEMS - MEMS reliability - scaling in MEMS; Recent research direction in MEMS: CMOS- MEMS integration - polymer MEMS - NEMS etc.

**Unit III: Sensor and Actuators**

9 Hours


**Unit IV: RF MEMS**

9 Hours

Switches: Cantilever MEMS based switch; Inductors and Capacitors: Modeling and design issues of planar inductor and capacitors; RF Filters: Modeling of mechanical filters; Phase Shifters: Classifications and limitations; Micro machined antennas: Micro-strip antennas - design parameters.

**Unit V: Instructional Activities**

9 Hours

Modeling, simulation and analysis of applications of MEMS switch, sensors and actuators using related platform.
Reference Books:


Hyperlinks:


ECENG 558
<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Periods</th>
<th>Credits</th>
<th>Total Hours</th>
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</thead>
<tbody>
<tr>
<td>ECENG 559</td>
<td>RF SYSTEM DESIGN</td>
<td>L T P</td>
<td>3</td>
<td>45</td>
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</table>

**Prerequisite**: Microwave engineering.

**Objective**: To impart RF system design for different applications.

**Outcome**: Students will be able to design different types of RF active components, devices and circuits.

**Unit I: RF Passive Components and Transmission Line Analysis** 9 Hours

High Frequency Components: Resistors- capacitors and inductors; Transmission line analysis - line equation - microstrip line - SWR - voltage reflection co-efficient - propagation constant - phase constant - phase velocity - Smith chart - parallel RL and RC circuits - ABCD parameters and S parameters.

**Unit II: RF Devices and Circuits** 9 Hours

RF amplifier design - power gain equations - maximum gain design, low noise amplifier design, high power amplifier design- stability considerations; RF oscillator design - one - port and two - port negative resistance oscillators - oscillator design using large - signal measurements; RF Mixer Design: Single ended mixer - double ended mixer.

**Unit III: RF feedback systems and Power amplifiers** 9 Hours

Stability of feedback systems: Gain and phase margin - root - locus techniques - time and frequency domain considerations - compensation ; General model - Class A, AB, B, C, D, E and F amplifiers - power amplifier linearization techniques - efficiency boosting techniques - ACPR metric- design considerations.

**Unit IV: PLL and Frequency synthesizers** 9 Hours

Linearised model - noise properties - phase detectors - loop filters and charge pumps – integer - N frequency synthesizers - direct digital frequency synthesizers.

**Unit V: Instructional Activities** 9 Hours

Simulation of the frequency response of amplifier, oscillator and mixer for different applications using related tools.
**Reference Books:**

**Hyperlinks:**
1. http://nptel.iitm.ac.in/syllabus/117105029

**ECENG 559**
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Name of the Course</th>
<th>Periods</th>
<th>Credits</th>
<th>Total Hours</th>
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</thead>
<tbody>
<tr>
<td>ECENG 630</td>
<td>ADVANCED TECHNOLOGIES IN WIRELESS NETWORKS</td>
<td>L  T  P</td>
<td>3</td>
<td>45</td>
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</table>

Prerequisite: Basics knowledge of computer and wireless networks.

Objective: To learn about the advanced topics in wireless networks with their architectures.

Outcome: Students will able to understand the various technologies in wireless networks.

Unit I: Wireless Area Networks

WPAN: System model - protocol stack of IEEE 802.15; Bluetooth: Network architecture - operation - specification; Radio Frequency Identification (RFID): Types and specifications; ZIGBEE and WBAN: section and architecture; WLAN: Network architecture - protocol stack of IEEE 802.11 - physical layer and MAC layer mechanism; WiMAX: BWA - issues and challenges of WiMAX - network architecture - protocol stack of IEEE 802.16 - differences between IEEE 802.11 and IEEE 802.16

Unit II: Wireless Sensor Network


Unit III: Wireless Internet


Unit IV: Wideband Wireless Technologies


Unit V: Instructional Activities

Simulation of minimum of five wireless networks standards using related tools.
References Books:

Hyperlinks:
2. www.tutorialspoint.com/wimax/

ECENG 630
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Name of the Course</th>
<th>Periods</th>
<th>Credits</th>
<th>Total Hours</th>
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<tbody>
<tr>
<td>ECENG 631</td>
<td>BIO SENSORS</td>
<td>L T P</td>
<td>3</td>
<td>45</td>
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**Prerequisite**: High speed semiconductor devices and MEMS

**Objective**: To make the students to understand the usage of different sensors for various biomedical applications.

**Outcome**: Students will be able to analyze different bio sensors and its effective usage for real time applications.

**Unit I: Introduction to Biosensors**

9 Hours

Basic principle of bio sensor- components of bio sensor- classification of biosensors - applications.

**Unit II: Semiconductors substrates**

9 Hours

Semiconductor substrates for bio electronics - silicon - diamond - chemical functionalization - covalent attachment of biomolecules to silicon surfaces - DNA modified silicon and diamond surfaces.

**Unit III: Immune sensors**

9 Hours

Anti body as bio recognition element: Types of anti-bodies and anti-body fragments; Types of immune sensors - labeled and label-free sensors - immune sensor applications.

**Unit IV: Transducers in Biosensors**

9 Hours

Piezoelectric semiconductor - impedimetric - mechanical and molecular electronics based transducers - Chemi - luminescence based bio sensors.

**Unit V: Instructional Activities**

9 Hours

Simulation of biosensors for various applications: clinical chemistry-medicine and health care-veterinary - industrial processes - environmental monitoring using related tools.
Reference Books:

Hyperlinks:

ECENG 631
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Name of the Course</th>
<th>Periods</th>
<th>Credits</th>
<th>Total Hours</th>
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</thead>
<tbody>
<tr>
<td>ECENG 632</td>
<td>COGNITIVE RADIO TECHNOLOGIES</td>
<td>L 2</td>
<td>T 1</td>
<td>P 0</td>
</tr>
</tbody>
</table>

Prerequisite: Fundamentals in wireless networks

Objective: To understand the requirements in designing software defined radios and cognitive radio with its functionalities.

Outcome: Students will be able to design the wireless network based on cognitive radio technology.

Unit I: Introduction 9 Hours
Fundamentals of communication networks: New challenges - multiple access schemes - cross layer design and optimization; Multicarrier modulation and equalization - ISI; RF spectrum and regulation: Regulatory issues of cognitive access.

Unit II: SDR Architecture 9 Hours

Unit III: CR Architecture 9 Hours
Cognitive radio network architectures: Architectures for spectrum sharing - network optimization - topology aware CRN architectures - Haykin dynamic spectrum architecture.

Unit IV: CR Network Security 9 Hours
Primary user emulation attacks - security vulnerabilities in IEEE 802.22 - security threats to the radio software.

Unit V: Instructional Activities 9 Hours
Simulation of CR & SDC network using related tools.
Reference Books:

Hyperlinks:

ECENG 632
<table>
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<tr>
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<th>Periods</th>
<th>Credits</th>
<th>Total Hours</th>
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<tbody>
<tr>
<td>ECENG 633</td>
<td>CONVERGENCE TECHNOLOGIES</td>
<td>L 2</td>
<td>T 1</td>
<td>P 0</td>
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**Prerequisite**: Basics of wireless networks, elementary concepts in probability, optimization related to communication systems.

**Objective**: To gain expertise in the convergence technologies in respect of network design and performance measures.

**Outcome**: Students will be able to enumerate the functions and importance of internetworking/interoperability of advanced wireless technologies.

**Unit I: Introduction**

9 Hours

Evolution towards convergence: Next generation network concept - framework for examining next generation and evolving networks - examples of application of framework - enabling mobile network technologies - opportunities and threats to the mobile converging service market.

**Unit II: Switching networks and convergence standards**

9 Hours


**Unit III: IP Telephony**

9 Hours

IP Telephony: Network architecture - IP Voice - VoIP call signaling protocols - IP cablecom - media networking - broadband infrastructure - IP TV - cloud computing - interoperability among multicasting/broadcasting systems - QoS.

**Unit IV: Software Methodologies for Converged Networks and Services**

9 Hours

Development of software methodologies for ICT: Software processes in the NGN framework - high level design and analysis methods - enterprise and business modeling notation - object and data definition language - dynamic modeling notations - component and interface notations - distributed systems - creating a unified framework.

**Unit V: Instructional Activities**

9 Hours

Simulation of minimum four convergence technologies for various applications using related tools.
Reference Books:


Hyperlinks:

1. www.radio-electronics.com/info/wireless/
2. www.radio-electronics.com/info/telecommunication_networks/

ECENG 633
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Name of the Course</th>
<th>Periods</th>
<th>Credits</th>
<th>Total Hours</th>
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<tbody>
<tr>
<td>ECENG 634</td>
<td>CARBON NANOTUBE DEVICES AND APPLICATIONS</td>
<td>L 2 T 1 P 0</td>
<td>3</td>
<td>45</td>
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</table>

**Prerequisite:** Knowledge in high speed semiconductor devices and their characteristics

**Objective:** To gain knowledge on the use of carbon nanotubes in organic electronic devices

**Outcome:** Students will be able to understand the carbon nano-tube device modeling and simulation and also the incorporation of functionalized carbon nano-tubes in Field Effect Transistor.

**Unit I: Basics of Carbon Nanotubes**
9 Hours
Carbon materials: Allotropes of carbon - structure and band diagram of carbon nanotubes - types of CNTs - electronic properties of CNTs; Band structure of Graphene: Band structure of SWNT from graphene - electron transport properties of SWNTs - scattering in SWNTs - carrier mobility in SWNTs.

**Unit II: Synthesis and Integration of SWNT Devices**
9 Hours
CVD synthesis: Method - direct incorporation with device fabrication process - SWNT synthesis on metal electrodes - lowering the synthesis temperature - controlling the SWNT growth - location - orientation - chirality - narrowing diameter distributions - chirality distribution analysis for different CVD processes - selective removal of the metallic nanotubes in FET devices - Integration.

**Unit III: Carbon Nanotube Field-Effect Transistors**
9 Hours
Schottky barrier heights of metal S/D contacts - high k-gate dielectric integration - quantum capacitance - chemical doping - hysteresis and device passivation - near ideal; Metal-contacted MOSFETs - SWNT MOSFETs - SWNT band-to-band tunneling FETs.

**Unit IV: Carbon Nanotube Device modeling**
9 Hours

**Unit V: Instructional Activities**
9 Hours
Device simulation of SWNT FETs: Assessing the AC response of top gated SWNT FETs; Power measurement using a spectrum analyzer - homodyne detection using SWNT FETs.
**References Books:**


**Hyperlink:**

1. [http://www.pa.msue.edu/cmp/csc/nttimeline.html](http://www.pa.msue.edu/cmp/csc/nttimeline.html)

ECENG 634
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Name of the Course</th>
<th>Periods</th>
<th>Credits</th>
<th>Total Hours</th>
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<tbody>
<tr>
<td>ECENG 635</td>
<td>EMBEDDED REAL TIME SYSTEM</td>
<td>L 2</td>
<td>T 1</td>
<td>P 0</td>
</tr>
</tbody>
</table>

**Prerequisite:** Fundamentals in advanced microcontrollers and embedded systems

**Objective:** To study various SOC, RTOS concept, programming of various communication interfaces for automatic systems

**Outcome:** Students will be able to understand the SOC concepts and the programming for automatic systems.

**Unit I: Introduction to Embedded Automatic Systems**  
9 Hours

**Unit II: SOC**  
9 Hours
Introduction to Arduino :Types of Arduino devices - common Arduino shields - Beagle Bone ; Introduction to Raspberry Pi

**Unit III: Communication Interfaces and Python Basics**  
9 Hours

**Unit IV: RTOS Programming**  
9 Hours
Tasks and Task states - semaphores - shared data - message queues - mail boxes and pipes - memory management - interrupt routines - encapsulating semaphore and queues - task management - inter task communication - process input/ output.

**Unit V: Instructional Activities**  
9 Hours
RFID based attendance management system - embedded video processing - home automation systems using Raspberry Pi/ Arduino /any other SOC.
Reference books:


Hyper Links:


ECENG 635
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Name of the Course</th>
<th>Periods</th>
<th>Credits</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECENG 636</td>
<td>FREE SPACE OPTICAL NETWORKS</td>
<td>L</td>
<td>T</td>
<td>P</td>
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</table>

**Prerequisite:** Fundamentals of optical communication and networks

**Objective:** To introduce the concepts of Terabit technology by means of optical wireless communications.

**Outcome:** Students will be able to design free space optical networks.

**Unit I: Introduction**  
9 Hours
Propagation of light in unguided media - laser beam characteristics - atmospheric effects on optical signals - coding for atmospheric optical propagation - factors affecting FSO - LOS - LIDAR; Overview of FSO optical transmitters - receivers - subsystems.

**Unit II: FSO Transceiver Design and Security**  
9 Hours
Light sources: Modulators - photo detectors and receivers - optical amplification - optical signal to noise ratio - acquisition, pointing and tracking - adaptive and active optics - laser safety - node housing and mounting; FSO inherent security levels and layers.

**Unit III: Point to Point FSO Systems**  
9 Hours
Simple PP design: Transponder nodes - hybrid FSO and RF - FSO point to multipoint - FSO point to mobile; Ring FSO systems: Ring topologies and service protection - ring nodes with add drop - concatenated rings - ring to network connectivity.

**Unit IV: Mesh FSO Systems**  
9 Hours
FSO Nodes for mesh topology : Hybrid mesh FSO with RF - hybrid FSO fiber networks; WDM Mesh FSO: DWDM and CWDM optical channels - WDM FSO links - WDM mesh FSO networks - service protection in mesh FSO networks.

**Unit V: Instructional Activities**  
9 Hours
Simulation of PP FSO system using ring topology / WDM Mesh FSO network with service protection enabled scenario - performance comparison of FSO networks in ring and mesh topology using related tools.
References Books:

Hyperlinks:

ECENG 636
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Name of the Course</th>
<th>Periods</th>
<th>Credits</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECENG 637</td>
<td>GREEN RADIO COMMUNICATION TECHNIQUES</td>
<td>L</td>
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<td>P</td>
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**Prerequisite**: Fundamentals of computer communication and wireless networks.

**Objective**: To impart the importance of energy conservation, CO₂ emission and inculcate green concepts for designing energy efficient next generation wireless networks.

**Outcome**: Students will be able to design green radio communication networks with energy efficient techniques.

**Unit I: Introduction**

9 Hours


**Unit II: Green Modulation and Co-operative Techniques**

9 Hours

Modulation and coding schemes with energy optimized techniques for wireless networks; Co-operative techniques for energy efficient wireless communications: Energy efficiency metrics for wireless networks - co-operative networks - optimizing the energy efficiency performance of co-operative networks - energy efficiency in co-operative base stations.

**Unit III: Base Station Power Management Techniques**

9 Hours

Base station power management techniques: Opportunistic spectrum and load management - energy saving techniques in cellular wireless base stations - power management for base stations in a smart grid environment.

**Unit IV: Wireless Access Techniques**

9 Hours


**Unit V: Instructional Activities**

9 Hours

Survey about minimum of four green communication networks and carry out simulation of those networks.
**Reference Books:**


**Hyperlinks:**


ECENG 637
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Name of the Course</th>
<th>Periods</th>
<th>Credits</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECENG 638</td>
<td>INTERNET OF EVERY THINGS (IoE)</td>
<td>L 2</td>
<td>T 1</td>
<td>P 0</td>
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</table>

**Prerequisite**: Basics of computer communication networks and wireless sensor networks

**Objective**: To study the architecture and security principles of Internet of Everything (IoE).

**Outcome**: Students will be able to design efficient IoE based projects.

**Unit I: Introduction**

IoT: Architectural overview - main design principles - standards considerations; M2M and IoT technology fundamentals; devices and gateways - data management - business processes in IoT - everything as a service - M2M and IoT analytics - knowledge management.

**Unit II: IoE Sensors**

Sensors for IoE: Wireless sensor structure - energy storage module - power management module - RF Module - sensing module.

**Unit III: IoE Security**

Security requirements in IoE architecture - security in enabling technologies - security concerns in IoE applications: Architecture - insufficient authentication/authorization - insecure access control - threats to access control, privacy, and availability - attacks specific to IoE.

**Unit IV: IoE Testbed**

ACOEM Eagle - EnOcean Push Button - NEST sensor - Ninja blocks focus on wearable electronics.

**Unit V: Instructional Activities**

Simulation of (minimum of any five) IoE applications - home and office infrastructures - security - home appliances and other IoE electronic equipment - interfacing of sensor with sensor node using any embedded target boards (Raspberry Pi / Intel Galileo/ARM Cortex/ Arduino).
Reference Books:


Hyperlinks:

2. https://www.codeproject.com/Learn/IoT/
3. https://www.edureka.co/blog/iot-tutorial/

ECENG 638
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Name of the Course</th>
<th>Periods</th>
<th>Credits</th>
<th>Total Hours</th>
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<tbody>
<tr>
<td>ECENG 639</td>
<td>MULTICARRIER WIRELESS COMMUNICATION</td>
<td>L 2</td>
<td>T 1</td>
<td>P 0</td>
</tr>
</tbody>
</table>

**Prerequisite**: Fundamentals of communication systems.

**Objective**: To impart OFDM transmitter and receiver system.

**Outcome**: Students will be able to understand the importance of OFDM techniques for wireless systems.

**Unit I: OFDM Principles**

System Model: Block diagram of OFDM system - generation of sub carrier using IFFT - guard time - cyclic extensions - windowing - choice of OFDM parameters - signal processing - bandwidth efficiency - peak to average power ratio - peak power problem - PAPR properties of OFDM signals; PAPR reduction techniques: Signal distortion techniques - multiple signaling and probabilistic techniques - coding techniques.

**Unit II: OFDM Time and Frequency Domain Synchronization**

System performance with frequency and timing errors; Synchronization algorithms - comparison of frequency acquisition algorithms - BER performance with frequency synchronization.

**Unit III: Adaptive Single and Multiuser OFDM Techniques**

Adaptive modulation for OFDM : Adaptive OFDM speech system - pre-equalization ; Comparison of adaptive techniques - near optimum power and bit allocation in OFDM - multiuser AOFDM - Multiuser systems - Maximum likelihood enhanced sphere decoding of MIMO OFDM.

**Unit IV: Channel Estimation in OFDM systems**

Pilot Based OFDM channel estimation-example; Comb Type Pilot (CTP) Transmission - example; Channel estimation in time/ frequency domain; Frequency Domain Equalization (FDE).

**Unit V: Instructional Activities**

BER Vs \(E_b/N_0\) for OFDM in AWGN channel- OFDM channel estimation using LS, LMMSE, and lower complexity LMMSE methods.
Reference Books:


Hyperlinks:


ECENG 639
<table>
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<th>Course Code</th>
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<tr>
<td>ECENG 640</td>
<td>NANO PHOTONICS</td>
<td>L2</td>
<td>T1</td>
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**Prerequisite**: Solid state physics and Quantum Physics.

**Objective**: To gain knowledge in photonic crystal and nano photonics.

**Outcome**: Students will be able to familiarize nano photonic systems with photonic crystal.

**Unit I: Basics of Nano photonics**
9 Hours
Photons and electrons - similarities and differences - free space propagation; Confinement of photons and electrons - propagation through a classically forbidden zone - tunneling - localization under a periodic potential - band gap; Cooperative effects - nano scale optical interactions - axial and lateral nanoscopic localization; Nano scale confinement of electronic interactions: Quantum confinement effects - nano scale interaction dynamics - nano scale electronic energy transfer; Cooperative emissions.

**Unit II: Quantum Confined Materials**
9 Hours
Inorganic semiconductors - quantum wells - quantum wires - quantum dots - quantum rings; Manifestation of quantum confinement: Optical properties - nonlinear optical properties - quantum confined stark effect - dielectric confinement effect - super lattices; Core-shell quantum dots and quantum wells - quantum confined structures as lasing media; Organic quantum - confined structures; Plasmonics.

**Unit III: Physics of Photonic Crystal**
9 Hours

**Unit IV: Applications**
9 Hours

**Unit V: Instructional Activities**
9 Hours
Simulation of band gap analysis of photonic crystal - waveguide bends - ring resonator using related tools.
References Books:

Hyperlinks:
1. https://www.nature.com/articles/nphys3668

ECENG 640
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<tr>
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<th>Total Hours</th>
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<tr>
<td>ECENG 641</td>
<td>PRINCIPLES OF ASIC DESIGN</td>
<td>L 3</td>
<td>T 0</td>
<td>P 0</td>
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**Prerequisite:** Digital VLSI Design

**Objective:** To make the students understand the architectural details of programmable ASICs including logic synthesis, floor-planning, placement and routing.

**Outcome:** The students will be able to gain sufficient theoretical knowledge for carrying out ASIC and FPGA design.

**Unit I: Introduction to Programmable Devices** 9 Hours

Programmable logic devices: ROM - PLA - PAL - PLD - FPGA - features, programming and applications using complex programmable logic devices; Speed performance and system programmability.

**Unit II: Introduction to ASIC** 9 Hours

Design flow - types of ASICs - full custom with ASIC - semi custom ASICs - standard cell based ASIC - gate array based ASIC - channeled – channel less - structured - data path elements - adders - multiplier - cell compilers ; Logical effort : Area and efficiency - paths - multi stage cells - optimum delay.

**Unit III: Low Level Design Language** 9 Hours

EDIF: PLA tools - introduction to CFI designs representation; Half gateASIC: Introduction to synthesis and simulation - two level logic synthesis - high level logic synthesis - VHDL and logic synthesis - types of simulation - boundary scan test - fault simulation - automatic test pattern generation.

**Unit IV: Floor Planning and Placement, and Routing** 9 Hours

Physical design: CAD tools - system partitioning - estimating ASIC size - partitioning methods; Floor planning tools - I/O and power planning - clock planning - placement algorithms - iterative placement improvement; Time driven placement methods - physical design flow global routing - local routing - detail routing - special routing - circuit extraction and DRC.

**Unit V: Instructional Activities** 9 Hours

Spartan 3E and Vertex Board Analysis - inputs and outputs - clock and power inputs - Xilinx I/O blocks - PLAs and PALs design using ASIC board.
**Reference Books:**


**Hyperlinks:**

1. en.wikipedia.org/wiki/Standard_cell
2. www.utdallas.edu/~zhoud/DesignEntry
3. en.wikipedia.org/wiki/High-level_synthesis

ECENG 641
<table>
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<tr>
<th>Course Code</th>
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<tr>
<td>ECENG 642</td>
<td>SOFT COMPUTING</td>
<td>L T P</td>
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**Prerequisite**: Basics of set theory.

**Objective**: To familiarize the salient approaches in soft computing based on artificial neural networks, fuzzy logic, and genetic algorithms.

**Outcome**: Students will be able to apply concepts of artificial neural networks, fuzzy logic, and genetic algorithm for real time applications.

**Unit I: Neural Network**


**Unit II: Fuzzy Sets & Logic**


**Unit III: Genetic Algorithm**

- Role of GA - fitness function - selection of initial population - cross over (different types) - mutation - inversion - deletion - constraints handling and applications of travelling salesman and graph coloring.

**Unit IV: Hybrid Systems**

- Hybrid Systems: GA based BPNN (Weight determination) - Neuro fuzzy systems - Fuzzy BPNN - fuzzy neuron - architecture - learning - Fuzzy logic controlled genetic algorithm.

**Unit V: Instructional Activities**

- Simulation of PSD - HSA and ACO related to either wireless networking or antenna or image processing using related tools.
Reference Books:

Hyperlinks:

ECENG 642
<table>
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<th>Periods</th>
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<th>Total Hours</th>
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<tr>
<td>ECENG 643</td>
<td>ULTRA WIDEBAND COMMUNICATION SYSTEMS</td>
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**Prerequisite**: Communication theory and wireless communication.

**Objective**: To impart the concepts of the UWB communication systems.

**Outcome**: Students will be able to design sub-modules of UWB system.

**Unit I: UWB Signals and Systems**

Introduction: Comparison of UWB with other wideband communication system - power spectral density - pulse shape - pulse trains - UWB spectrum and spectral masks - multipath and penetration characteristics - spatial and spectral capacities - speed of data transmission - Gaussian waveforms - designing waveforms for specific spectral masks - practical constraints and effects of imperfections - applications of UWB systems.

**Unit II: UWB Pulse Generation and Processing**

UWB signal generation: UWB modulation schemes - transmitter and receiver - multiple access techniques - capacity - interference and coexistence of UWB with other systems - Hermite pulses - Orthogonal prolate spheroidal wave functions - wavelet packets in UWB PSM - signal processing: effects of a lossy medium on a UWB transmitted signal - time domain analysis - frequency domain techniques.

**Unit III: UWB Channel Modeling**

IEEE proposals for UWB channel models - simplified UWB multipath channel model - path loss model - two-ray UWB propagation model - frequency domain autoregressive model - MIMO for UWB systems - self interference in high data-rate UWB communications - coexistence of UWB with WIMAX and other short range wireless radios.

**Unit IV: UWB Antennas and Filters**

Antenna fundamentals - antenna radiation for UWB signals - conventional antennas and impulse antennas for UWB systems - beam forming for UWB signals - UWB filters - prototype characteristics - filtering techniques - wireless positioning and location - GPS techniques - positioning techniques - time resolution issues - UWB positioning and communications.

**Unit V: Instructional Activities**

Simulation of UWB: Pulse generation and processing - channel modeling - antennas using EM - MIMO for UWB systems using related tools.
Reference Books:

Hyperlinks:

ECENG 643
<table>
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<th>Periods</th>
<th>Credits</th>
<th>Total Hours</th>
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<tr>
<td>ECENG 644</td>
<td>VEHICULAR AD-HOC NETWORKS (VANET)</td>
<td>L T P</td>
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Prerequisite: Wireless communication and network, and mobile ad-hoc networks

Objective: To introduce the students with the emerging technologies and their standards with applications for vehicular communication systems.

Outcome: Students will able to understand the basic principles, standards, and system architecture of Vehicular Ad-hoc Networks.

Unit I: Introduction 9 Hours
Basic principles and challenges - past and ongoing VANET activities; Cooperative vehicular safety applications: Introduction - enabling technologies - cooperative system architecture.

Unit II: Vehicular Mobility Models 9 Hours
Introduction - notation description - random models - flow models - traffic models - behavioral models - trace or survey based models - integration with network simulators - design framework for realistic vehicular mobility models.

Unit III: Routing Protocols 9 Hours

Unit IV: Security 9 Hours
Requirement - challenges - adversaries - VANET supporting properties - message authentication and integrity using Digital Signatures - detection of malicious data and secure position verification.

Unit V: Instructional Activities 9 Hours
Simulation of vehicle to vehicle communication - vehicle to infrastructure and infrastructure to vehicle communication using related tools.
**Reference Books:**


**Hyperlinks:**

1. [http://www.irma-international.org/viewtitle/43163/](http://www.irma-international.org/viewtitle/43163/)

ECENG 644

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