Master of Technology
in
Communication and Information Systems

Regulations, Curriculum and Syllabus
(With Effect from 2019-2020)

Department of Electronics Engineering
School of Engineering and Technology
Pondicherry University
Puducherry - 605 014
INDIA
i) CBCS Regulations for M.Tech. (Communication and Information Systems)

The Department of Electronics Engineering under the School of Engineering and Technology, Pondicherry University, Pondicherry was 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. (Communication and Information Systems)</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/ Information Technology 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>21 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>72 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: 75% of marks for internal and 25% for end semester examinations.

NPTEL/MOOC/GIAN 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>First Review</td>
</tr>
<tr>
<td>10 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 (SCI/Scopus/Web of Sciences) 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 one of the even end semester examinations 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) **Curriculum for M.Tech. (Communication and Information Systems)**

### 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>ECIS 510</td>
<td>Communication Systems Laboratory</td>
<td>H</td>
<td>0-0-4</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>ECIS 511</td>
<td>Advanced Digital Communication</td>
<td>H</td>
<td>3-1-0</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>ECIS 512</td>
<td>Communication Networks</td>
<td>H</td>
<td>3-1-0</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>ECIS 513</td>
<td>Error Correcting Codes</td>
<td>H</td>
<td>3-1-0</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>ECIS 514</td>
<td>Probability and Random Process</td>
<td>H</td>
<td>3-1-0</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Elective I</td>
<td>S</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>Elective II</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>ECIS 520</td>
<td>Information Systems Laboratory</td>
<td>H</td>
<td>0-0-4</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>ECIS 521</td>
<td>Adaptive Signal Processing</td>
<td>H</td>
<td>3-1-0</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td>ECIS 522</td>
<td>Advanced Computer Architecture</td>
<td>H</td>
<td>3-1-0</td>
<td>4</td>
</tr>
<tr>
<td>11</td>
<td>ECIS 523</td>
<td>Advanced Wireless Communication</td>
<td>H</td>
<td>3-1-0</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>ECIS 524</td>
<td>Information and Network Security</td>
<td>H</td>
<td>3-1-0</td>
<td>4</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td>Elective III</td>
<td>S</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>Elective IV</td>
<td>S</td>
<td>2-1-0</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Credits for Semester II** 24

(H – Hard Core Course; S – Soft Core Course)
### III 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>15</td>
<td></td>
<td>Elective V</td>
<td>S</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>16</td>
<td></td>
<td>Elective VI</td>
<td>S</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>17</td>
<td></td>
<td>Elective VII</td>
<td>S</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>18</td>
<td>ECIS 611</td>
<td>NPTEL/MOOC/GIAN course</td>
<td>H</td>
<td>0-2-0</td>
<td>2</td>
</tr>
<tr>
<td>19</td>
<td>ECIS 612</td>
<td>Project - Literature Survey</td>
<td>H</td>
<td>0-0-1</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total Credits for Semester III** 12

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

### IV 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>20</td>
<td>ECIS 620</td>
<td>Project and Viva Voce</td>
<td>H</td>
<td>0-0-12</td>
<td>12</td>
</tr>
<tr>
<td>21</td>
<td>ECIS 621</td>
<td>Publication</td>
<td>-</td>
<td>-</td>
<td>0</td>
</tr>
</tbody>
</table>

**Total Credits for Semester IV** 12

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

**Total number of credits required to complete**
M.Tech (Communication and Information Systems) : 72 Credits
### Semester I – List of Electives

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course Code</th>
<th>Name of the Course</th>
<th>L-T-P</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ECIS 530</td>
<td>Advanced Electromagnetics</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>ECIS 531</td>
<td>Database Design</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>ECIS 532</td>
<td>Data Mining and Data Warehousing</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>ECIS 533</td>
<td>Embedded System Design and Architecture</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>ECIS 534</td>
<td>Image Processing Techniques</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>ECIS 535</td>
<td>Optical Communication</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>ECIS 536</td>
<td>Satellite Communication</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>ECIS 537</td>
<td>Software Architecture and Interoperability</td>
<td>2-1-0</td>
<td>3</td>
</tr>
</tbody>
</table>

### Semester II - List of Electives

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course Code</th>
<th>Name of the Course</th>
<th>L-T-P</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ECIS 550</td>
<td>Advanced Technologies in Wireless Networks</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>ECIS 551</td>
<td>Management Information Systems</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>ECIS 552</td>
<td>Modeling and Simulation of Communication Systems</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>ECIS 553</td>
<td>Multimedia systems</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>ECIS 554</td>
<td>Network Administrative Systems</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>ECIS 555</td>
<td>Pattern Recognition and Artificial Intelligence</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>ECIS 556</td>
<td>Radiation Systems</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>ECIS 557</td>
<td>Speech and Audio Processing</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>Sl. No</td>
<td>Course Code</td>
<td>Name of the Course</td>
<td>L-T-P</td>
<td>Credits</td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
<td>--------------------------------------------------------</td>
<td>--------</td>
<td>---------</td>
</tr>
<tr>
<td>1</td>
<td>ECIS 630</td>
<td>Advanced Distributed Systems</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>ECIS 631</td>
<td>Big Data Analytics</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>ECIS 632</td>
<td>Cloud Storage and Computing</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>ECIS 633</td>
<td>Cognitive Radio</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>ECIS 634</td>
<td>Convergence Technologies</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>ECIS 635</td>
<td>Cooperative Communication Systems</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>ECIS 636</td>
<td>Free space Optical Networks</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>ECIS 637</td>
<td>Green Radio Communication Networks</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>ECIS 638</td>
<td>Internet of Every Thing (IoET)</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>ECIS 639</td>
<td>Low Power Digital VLSI Design</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>11</td>
<td>ECIS 640</td>
<td>Real Time Operating System</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>12</td>
<td>ECIS 641</td>
<td>Sensors and Actuators</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>13</td>
<td>ECIS 642</td>
<td>Soft Computing</td>
<td>2-1-0</td>
<td>3</td>
</tr>
<tr>
<td>14</td>
<td>ECIS 643</td>
<td>Vehicular Ad-hoc Networks (VANET)</td>
<td>2-1-0</td>
<td>3</td>
</tr>
</tbody>
</table>
iii) Syllabus for M.Tech. (Communication and Information Systems)

<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>ECIS 510</td>
<td>COMMUNICATION SYSTEMS LABORATORY</td>
<td>L 0</td>
<td>T 0</td>
<td>P 4</td>
</tr>
</tbody>
</table>

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

OUTCOME: Students will be able to design, implement/ simulate various functional modules of a communication system.

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

SOFTWARE:
1. Modulation in AWGN/ Wireless communication channel
2. Observation (simulation) of signal constellations of BPSK, QPSK and QAM
3. Error control / Line coding schemes
4. QMF
5. Wireless channel equalizer (ZF/LMS/RLS)
6. OFDM transceiver system
7. MIMO system (STBC/STTC)

HARDWARE:
8. Spectral analysis of modulation signals using spectrum analyzer
9. S Parameters characterization of antennas using network analyzer
10. Performance evaluation of digital data transmission techniques through optical fiber link
11. GMSK modulation
12. Study of CDMA system
13. Study of GPS system
14. Study of MIMO-OFDM system
15. Study of SDR.

ECIS 510
<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>ECIS 511</td>
<td>ADVANCED DIGITAL COMMUNICATION</td>
<td>L:3 T:1 P:0</td>
<td>4</td>
<td>60</td>
</tr>
</tbody>
</table>

**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

Optimum receiver for channels with ISI and AWGN – Nyquist criterion for zero ISI - linear equalization and its variations - decision feedback equalization - predictive decision feedback equalization - turbo equalization.

**Unit IV: Synchronization** 12 Hours


**Unit V: Activities Based Learning** 12 Hours

Simulation: Different digital modulations - 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

ECIS 511
<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>ECIS 512</td>
<td>COMMUNICATION NETWORKS</td>
<td>L 3 T 1 P 0</td>
<td>4</td>
<td>60</td>
</tr>
</tbody>
</table>

**Prerequisite:** Computer Networks, Wireless and Optical Communication

**Objective:** To understand the architecture and standards of wireless & optical networks.

**Outcome:** Students will be able to design state-of-the-art communication networks for real time scenario.

**Unit I: Introduction to Networks**  
12 Hours


**Unit II: Wireless Networks**  
12 Hours


**Unit III: Optical Networks**  
12 Hours

Optical Networks: SONET / SDH - WDM networks - FTTX – Metropolitan area networks; Broadcast and select networks - topologies for broadcast networks - testbeds for broadcast and select networks; Wavelength routing architecture and testbeds; WOBAN and OTDM networks.

**Unit IV: Inter Networking between WLANS and 3GWANs**  
12 Hours

Internetworking - objectives and requirements - schemes to connect WLANs and 3G networks - session mobility - internetworking architecture for WLAN and GPRS, LMDS, MMDS-Internetworking of WiMAX and LTE

**Unit V: Activities Based Learning**  
12 Hours

Simulation of minimum (3) wireless communication networks scenario using related simulation tool.
Reference Books:


Hyperlinks:

3. https://books.google.co.in/books/about/LTE_and_the_Evolution_to_4G_Wireless.html?id=PG0DDQAAQBAJ&redir_esc=y

ECIS 512
<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>ECIS 513</td>
<td>ERROR CORRECTING CODES</td>
<td>L 3 T 1 P 0</td>
<td>4</td>
<td>60</td>
</tr>
</tbody>
</table>

**Prerequisite**: Digital Logic Design and Circuits

**Objective**: To make the students to understand the concepts of various error detecting and correcting codes.

**Outcome**: Students will able to design an error detecting and correcting codes for real time communication system.

**Unit I: Introduction** 12 Hours
Coding: Basic definitions - block codes - maximum likelihood decoding - decoding tables - hamming weight and distance - error correction vs detection.

**Unit II: Linear Block Codes** 12 Hours
Definition - generator matrix - parity check matrix - error detection and correction capability of a linear code - standard array.

**Unit III: Binary Cyclic Codes and Convolutional Codes** 12 Hours
Cyclic codes: Description of Cyclic Codes - encoding with (n-k) stage shift register - syndrome calculations and error detection - a general decoder for cyclic codes - shortened cyclic codes.

**Unit IV: Error Trapping Decoding for Cyclic Codes** 12 Hours
Error trapping decoding - Hamming codes - double-error-detecting and single-error-correcting Hamming Codes - a modified error - trapping decoding - Goley code; BCH Codes: Decoding of the BCH Codes - implementation of error correction – non binary BCH Codes and Reed-Solomon codes.

**Unit V: Activities Based Learning** 12 Hours
Simulation of minimum of (3) error correcting/ detecting codes using related simulation tools.
Reference Books:


Hyperlinks:


ECIS 513
<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>ECIS 514</td>
<td>PROBABILITY AND RANDOM PROCESS</td>
<td>L T P</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 1 0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Prerequisite:** Knowledge in Set theory and Communication systems.

**Objective:** To make the students to understand various random processes and its conditions, and also the concepts of information theory

**Outcome:** Students will be able to analyze the probability related concepts and its applications.

**Unit I: Introduction**  
12 Hours

Sample space - events - joint and conditional probability – Baye’s theorem; Definition of a random variable - Expected value of a random variable; Central moments- variance - skew; Continuous random variable, non-monotonic transformations of continuous random variable; Probability density function - cumulative distribution function - probability mass function.

**Unit II: Random Processes**  
12 Hours

Random process concept - first order stationary processes - second order and wide sense stationarity - nth order and strict sense stationarity - time averages and ergodicity; Autocorrelation function and its properties - cross correlation function and its properties; Gaussian random processes - Poisson random process; Entropy: joint and conditional entropy - relative entropy and mutual information - maximum entropy distributions - inequalities in information theory.

**Unit III: Linear Algebra**  
12 Hours


**Unit IV: Markov Processes**  
12 Hours


**Unit V: Activities Based Learning**  
12 Hours

Simulation of entropy, random and Markov process for real time applications using suitable software packages.
Reference Books:


Hyperlinks:

2. http://tinyheero.github.io/2016/03/20/basic-prob.html

ECIS 514
<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>ECIS 520</td>
<td>INFORMATION SYSTEMS LABORATORY</td>
<td>L T P</td>
<td>2</td>
<td>60</td>
</tr>
</tbody>
</table>

**OBJECTIVE:**

Hands-on experience on software experiments in order to acquire sufficient knowledge and understand practical nuances of various information systems techniques.

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

1. Simulation using any open source tools
   a. Determination of various entropies and mutual information for various channels
   b. Generate and evaluate variable length source coding using a) Shannon – Fano coding and decoding b) Huffman coding and decoding
   c. K-means clustering algorithm
   d. Bayes classification

2. Simulation using any open source tools
   a. Performance evaluation of different queues, effect of queues and buffers in wired network environment
   b. Performance analysis of Ethernet LAN using N nodes
   c. Throughput analysis of wireless network consisting of TCP and UDP traffic
   d. Throughput and delay analysis of different wireless routing protocols (AODV/DSR/DSDV)
   e. Creation and analysis of Mobile IP scenario

3. Simulation using C/C++
   a. Data sorting methods to arrange a list of integers in ascending order:
      i) Insertion sort
      ii) Merge sort.
   b. i) Create a binary search tree of characters.
       ii) Traverse the above Binary search tree recursively in post order.
   c. Leaky bucket algorithm for congestion control
   d. Dijkstra’s algorithm to compute the shortest path through a graph.
   e. Data link layer framing method - bit stuffing.

4. Simulation using any operating systems
   a. Communication commands (mail, write, talk)
   b. Process related commands (ps, nohup, archiving)
   c. Shell programming commands (shell variables, read, while)
   d. Setting up servers (DHCP, DNS, NFS)
   e. System administration (Booting, init, runlevel)

**ECIS 520**
<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>ECIS 521</td>
<td>ADAPTIVE SIGNAL PROCESSING</td>
<td>3 L 1 T 0 P</td>
<td>4</td>
<td>60</td>
</tr>
</tbody>
</table>

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

**Objective:** To make the students to understand the concepts in advanced signal processing mechanisms and filtering techniques.

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

**Unit I: Fundamentals of Adaptive Signal Processing**

Introduction: Linear optimum filters - adaptive filters - linear filter structures - approaches to the development of linear adaptive filters - adaptive beam forming - four classes of applications - correlation matrix - properties of correlation matrix.

**Unit II: Linear Prediction**


**Unit III: Steepest Descent and LMS**

**Method of Steepest Descent:** Basic idea - steepest descent algorithm applied to Wiener filters - stability - limitations.

**LMS algorithm:** Overview - LMS adaptation algorithms - stability and performance analysis of LMS Algorithms - LMS gradient and stochastic algorithms - convergence of LMS algorithm.

**Unit IV: Recursive least squares adaptive filters**

Matrix inversion - lemma - exponentially weighted recursive least squares algorithm - recursion for updating the sum of weighted error squares - convergence.

**Unit V: Activities Based Learning**

Simulation of adaptive channel equalizers - adaptive noise canceling - adaptive echo cancellers using related software packages.
Reference Books:

Hyperlinks:

ECIS 521
<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>ECIS 522</td>
<td>ADVANCED COMPUTER ARCHITECTURE</td>
<td>L 3 T 1 P 0</td>
<td>4</td>
<td>60</td>
</tr>
</tbody>
</table>

**Prerequisite:** Basic knowledge on computer organization.

**Objective:** The students will acquire the knowledge about technical competence in computer architecture and high-performance computing.

**Outcome:** Students will be able to describe the performance enhancements such as pipelining and parallelism, multi-core architectures.

**Unit I: Fundamentals of Computer Design** 12 Hours
Overview of fundamentals of CPU - memory and I/O - computer performance evaluation, quantitative principles of computer architecture - instruction set architecture; RISC and CISC.

**Unit II: Parallelism Overview** 12 Hours
Instruction level parallelism: ILP concepts - compiler techniques for exposing ILP - dynamic branch prediction - dynamic scheduling - multiple instruction issue - hardware based speculation - static scheduling - multi-threading - limitations of ILP; Data Level Parallelism: Vector architecture - SIMD extensions - graphics processing units; Thread level parallelism: Symmetric and distributed shared memory architectures - performance issues - synchronization - models of memory consistency.

**Unit III: Pipelining Concepts** 12 Hours

**Unit IV: Multi-Processor** 12 Hours
Introduction - characteristics - memory organization for multi-processor systems - synchronization and models of memory consistency - issues of deadlock and scheduling in multiprocessor systems - cache in multiprocessor systems - parallelism algorithm and pipelining techniques for multiprocessor systems.

**Unit V: Activities Based Learning** 12 Hours
Case studies: Software and hardware multithreading - SMT and CMP architectures - Intel multi-core architecture - SUN CMP architecture - heterogeneous - multi-core processors - IBM cell processor.
Reference Books:


Hyperlinks:

2. https://lecturenotes.in/subject/110/advanced-computer-architecture-aca

ECIS 522
<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>ECIS 523</td>
<td>ADVANCED WIRELESS COMMUNICATIONS</td>
<td>L:3 T:1 P:0</td>
<td>4</td>
<td>60</td>
</tr>
</tbody>
</table>

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
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
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
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
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: Activities Based Learning
Simulation of minimum of (two) modulation, multiple access technique and MIMO systems for wireless communication system using related tools.
Reference Books:

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

ECIS 523
Course Code | Name of the Course | Periods | Credits | Total Hours
--- | --- | --- | --- | ---
ECIS 524 | INFORMATION AND NETWORK SECURITY | L T P | 4 | 60

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 12 Hours

Unit II: Data Security and Authentication 12 Hours
Triple DES with two keys - stream cipher - RC4 - RSA algorithm - elliptical curve cryptography algorithm; MD5 - HASH algorithm - SHA 512 logic - Digital signature standards.

Unit III: Network Security 12 Hours

Unit IV: System Security 12 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: Activities Based Learning 12 Hours
Simulation of minimum of (three) public key and private key cryptography algorithms - authentication algorithms using related tools.
References Books:


Hyperlinks:

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

ECIS 524
**Course Code** | **Name of the Course** | **Periods** | **Credits** | **Total Hours**
---|---|---|---|---
ECIS 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 circuits

---

**Unit I: Electromagnetic Waves**

Maxwell Equations: Integral and differential form - constitutive relations - time dependent wave equations - boundary conditions - polarization - time harmonic fields - Poynting theorem - mode concepts - guided waves - TE & TM waves in a rectangular waveguide and circular waveguide - the coaxial transmission line - Smith chart and its applications.

- **9 Hours**

**Unit II: Theorems and Concepts**

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.

- **9 Hours**

**Unit III: Time Varying Harmonic Electromagnetic Fields**

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.

- **9 Hours**

**Unit IV: Integral Equation in Momentum Method**

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.

- **9 Hours**

**Unit V: Activities Based Learning**

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.

- **9 Hours**
Reference Books:

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

ECIS 530
<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>ECIS 531</td>
<td>DATABASE DESIGN</td>
<td>L(2) T(1) P(0)</td>
<td>3</td>
<td>45</td>
</tr>
</tbody>
</table>

**Prerequisite:** Knowledge in Data structures, C language.

**Objective:** To make the students to understand the concepts in data processing and management.

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

**Unit I: Data Base System**
9 Hours
File system Vs DBMS - advantages of DBMS - queries in DBMS - structure of DBMS - entities - attributes - entity sets - features of ER model - the relational model.

**Unit II: Relational Algebra**
9 Hours
Relational algebra - selection and projection set operations - renaming - joins – divisions - examples of algebra overviews - expressive power of algebra and calculus.

**Unit III: SQL**
9 Hours
Form of basic SQL query - examples of basic SQL queries - introduction to nested queries - correlated nested queries set - comparison operators - aggregative operators - NULL values - comparison using null values - logical connectivity’s – AND, OR and NOT - impact on SQL constructs - outer joins disallowing NULL values - complex integrity constraints in SQL0 triggers and active data bases.

**Unit IV: Normalization**
9 Hours
Schema refinement - problems caused by redundancy - decompositions - problems related to decomposition - reasoning about FDS - FIRST, SECOND, THIRD normal forms - BCNF - loss less join decomposition - dependency preserving decomposition - schema refinement in data base design - multi valued dependencies - fourth normal form; Transactions and column control.

**Unit V: Activities Based Learning**
9 Hours
Case study on implementation of data base management for the applications in banking, educational sector and online shopping.
**Reference Books:**


**Hyperlinks:**


ECIS 531
Table:

<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>ECIS 532</td>
<td>DATA MINING AND DATA WAREHOUSING</td>
<td>L 2</td>
<td>T 1</td>
<td>P 0</td>
</tr>
</tbody>
</table>

**Prerequisite:** Database Systems

**Objective:** To understand the advanced aspects of data warehousing and data mining, encompassing the principles and commercial application of the technologies.

**Outcome:** Students will be able to understand the emerging architectures behind the analysis and mining of "big data".

**Unit I: Data Mining**

Data Mining: Functionalities - data preprocessing - data cleaning - data integration and transformation - data reduction - data discretization and concept hierarchy generation; Association rule mining: Efficient and scalable frequent item set mining methods - mining association rules - association mining to correlation analysis - constraint based association mining; web data mining.

**Unit II: Classification and Prediction**

Classification and prediction issues; Classification: Decision tree - Bayesian - rule based - back propagation - support vector machines - associative classification - lazy learners - other classification methods, prediction accuracy and error measure; Evaluation of classifier or predictor - ensemble methods - model section.

**Unit III: Cluster Analysis**


**Unit IV: Data Warehousing and Business Analysis**

Data warehousing components - building a data warehouse - mapping the data warehouse to a multiprocessor architecture - DBMS schemas for decision support - data extraction - cleanup and transformation tools - metadata reporting - query tools and applications; Online Analytical Processing (OLAP) – OLAP and multidimensional data analysis.

**Unit V: Activities Based Learning**

Simulation on Spatial Data Mining; Multimedia Data Mining; Text Mining, Mining the World Wide Web.
Reference Books:

Hyperlinks:
2. www.autonlab.org/tutorials
3. wwwdb.standford.edu/~ullman/mining/mining.html
4. www.kdnuggets.com

ECIS 532

32
<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>ECIS 533</td>
<td>EMBEDDED SYSTEM DESIGN AND ARCHITECTURE</td>
<td>L 2</td>
<td>T 1</td>
<td>P 0</td>
</tr>
</tbody>
</table>

**Prerequisite:** Basics knowledge on Computer peripherals and Programming in C.

**Objective:** Students to learn the understanding of embedded systems design concepts and also know typical engineering issues in software development.

**Outcome:** Students will be able to familiar with programming environment used to develop embedded systems and also understood the key concepts of embedded systems like I/O, timers, interrupts.

**Unit I: Introduction to Embedded Systems**
9 Hours
Embedded system model - embedded standards - block diagrams - powering the hardware - embedded board using von Neumann model; Embedded processors: ISA architecture - different ISA models - application specific ISA models - general purpose ISA models.

**Unit II: Processor and Memory**
9 Hours

**Unit III: AVR Microcontroller and ARM Architecture**
9 Hours

**Unit IV: Embedded Programming**
9 Hours
C and Assembly programming: Programming style - declarations and expressions - arrays, qualifiers and reading numbers - decision and control statements; Basics of PYTHON programming: syntax and style - python objects - dictionaries - comparison with C programming on conditionals and loops - files - input and output - errors and exceptions - functions - modules - classes and OOP - execution environment.

**Unit V: Activities Based Learning**
9 Hours
Simulation of various interfaces using AVR/ARM/PIC microcontrollers for different applications (Home/Machine/Bio-Medical automation) using related software packages.
Reference Books:

Hyperlinks:

ECIS 533
<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>ECIS 534</td>
<td>IMAGE PROCESSING TECHNIQUES</td>
<td>L 2 T 1 P 0</td>
<td>3</td>
<td>45</td>
</tr>
</tbody>
</table>

**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 forensics**
9 Hours

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

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

ECIS 534
<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>ECIS 535</td>
<td>OPTICAL COMMUNICATION</td>
<td>L2 T1 P0</td>
<td>3</td>
<td>45</td>
</tr>
</tbody>
</table>

**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 able to understand the potential of physical layer of optical system and its applications.

**Unit I: Introduction**
9 Hours

Prologue: Historical perspective – light sources – modulators; Fiber losses - signal dispersion - signal propagation - 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**
9 Hours

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**
9 Hours

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**
9 Hours

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: Activities Based Learning**
9 Hours

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

**ECIS 535**
<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>ECIS 536</td>
<td>SATELLITE COMMUNICATION</td>
<td>L T P</td>
<td>3</td>
<td>45</td>
</tr>
</tbody>
</table>

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

Hyperlinks:

ECIS 536
Prerequisite: Basic knowledge in computational electromagnetics and fuzzy logic.

Objective: To learn the importance of software architecture, life cycle and Interoperability challenges.

Outcome: Students will be able to understand the basic principles of software architecture and interoperability.

Unit I: Introduction 9 Hours
Software Architecture - architecture structures and views - importance of software architecture - predicting system quality - influencing organizational structure – improving cost and schedule estimates - context of software architecture.

Unit II: Life Cycle Architecture 9 Hours
Architecture of agile projects - its requirements - designing and documentation - implementation and testing - architecture reconstruction and conformance; Architecture in cloud: Cloud definition - service model - economic justification - base mechanism - edge architecture - edge document system - SDLC - metropolis model.

Unit III: Interoperability 9 Hours
Physical vs Virtual - data interoperability - semantic interoperability - organizational interoperability - eternal interoperability - important economic dimension - roadmap for IoT testing methodologies.

Unit IV: Quality Attributes 9 Hours

Unit V: Activities Based Learning 9 Hours
Case Study: Evolving software architecture for food and drug administration and generic drug application process; NATO Multilateral interoperability.
Reference Books:

Hyperlinks:

ECIS 537
<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>ECIS 550</td>
<td>ADVANCED TECHNOLOGIES IN WIRELESS NETWORKS</td>
<td>L T P</td>
<td>3</td>
<td>45</td>
</tr>
</tbody>
</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 be able to understand the various technologies in wireless networks.

**Unit I: Wireless Area Networks** 9 Hours
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** 9 Hours

**Unit III: Wireless Internet** 9 Hours

**Unit IV: Wideband Wireless Technologies** 9 Hours

**Unit V: Activities Based Learning** 9 Hours
Simulation of minimum of five wireless networks standards using related tools.
Reference Books:

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

ECIS 550
<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>ECIS 551</td>
<td>MANAGEMENT INFORMATION SYSTEMS</td>
<td>L:2 T:1 P:0</td>
<td>3</td>
<td>45</td>
</tr>
</tbody>
</table>

**Prerequisite:** Basic knowledge about information systems.

**Objective:** To study the concepts of information systems and their general applications.

**Outcome:** Students will be able to develop system design essential for management information systems.

**Unit I: Introduction**  
9 Hours

**Unit II: Integrated Construction Management**  
9 Hours
Integrated Construction Management - information system - project management information system- functional areas finance - marketing production - personnel levels - DSS - EIS - ES - comparison, concepts and knowledge representation - managing international information system.

**Unit III: Hardware Software Overview**  
9 Hours
Information Technology (IT) trends - IT trends in hardware - information system software - application software - software concepts - geographical information systems - electronic data interchange.

**Unit IV: System Design**  
9 Hours
System design: Data flow diagrams - Decision analysis -Structured analysis - structured system design - module design - design of programs.

**Unit V: Activities Based Learning**  
9 Hours
Case study: Financial Management Information System (FMIS); Marketing MIS: Product development and delivery - sales report.
Reference Books:


Hyperlinks:

1. http://nptel.ac.in/courses/106101061/17

2. http://nptel.ac.in/courses/122105022/


ECIS 551
Prerequisite : Basic concepts of Probability, Random processes, Numerical methods and Digital Signal Processing.

Objective : To impart the basic concepts of modeling and simulation of communication.

Outcome : Students will be able to apply modeling and computational techniques to problems in communication field.

Unit I: Introduction 9 Hours
Simulation and modeling methodology: Review of random processes - univariate and multivariate models - transformation of random variables - bounds and approximations; Random process models: Markov and ARMA sequences - Poisson process - Gaussian process; Random number generation; Generation of random sequences; Testing random number generators.

Unit II: Modeling of Transmitter and Receiver subsystems 9 Hours
Information sources - channel coding - radio frequency and optical modulation; Demodulation and detection - filtering; Multiple Access: Issues in the simulation of multiple access.

Unit III: Communication channels and models 9 Hours
Fading and multipath channels; Free space channel; Conducting and Guided wave media; Finite state channel models; Methodology for simulating communication systems operating over fading channels.

Unit IV: Estimation of parameters and performance 9 Hours
Estimation of parameters through simulation: Quality of an estimator - estimating average level - average power - power spectral density - delay and phase; Estimation of performance measures from simulation: SNR; Estimating performance measures for digital systems: The Monte Carlo method, importance sampling method; Variance reduction techniques.

Unit V: Activities Based Learning 9 Hours
Simulation study: Generating PDF for the Gaussian and non-Gaussian distributions; Modeling of transmitter and receiver subsystems; Estimation of parameters and performance for communication system.
Reference Books:

Hyperlinks:

ECIS 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>ECIS 553</td>
<td>MULTIMEDIA SYSTEMS</td>
<td>L 2 T 1 P 0</td>
<td>3</td>
<td>45</td>
</tr>
</tbody>
</table>

**Prerequisite**: Fundamentals of communication systems and computer networks

**Objective**: To understand the various concepts of hardware and software used in multimedia and to get familiar with the various file formats used in multimedia.

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

**Unit I: Introduction**  
9 Hours
Multimedia system architecture - multimedia elements - media and data stream - data stream characteristics - main properties of multimedia system - evolving technologies for multimedia systems - multimedia databases - multimedia applications.

**Unit II: Multimedia Input and Output Technologies**  
9 Hours
Key technology issues - pen input - image and video display systems - video images and animation - full motion video - sensors for TCV cameras - print output technologies - image scanners - digital audio and computers video technology raster scanning principles.

**Unit III: Wireless Multimedia Communication**  
9 Hours

**Unit IV: Storage and Retrieval Technologies**  
9 Hours

**Unit V: Activities Based Learning**  
9 Hours
Case study: Integration of academic and business sector activities - Computer-Based Training (CBT) - Computer Aided Learning (CAL) technologies.
Reference Books:

Hyperlinks:

ECIS 553
<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>ECIS 554</td>
<td>NETWORK ADMINISTRATIVE SYSTEMS</td>
<td>L T P</td>
<td>3</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 1 0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Prerequisite**: Knowledge in Computer Networks, Network Security.

**Objective**: To make the students to understand the concepts in network layers, protocols.

**Outcome**: Students will be able to analyze and implement network management techniques for various applications.

**Unit I: Introduction**

Internet administration and standards - OSI model and TCP/IP protocol; Examples of networks: novel networks – Arpanet - Internet; Network topologies: LAN- MAN- WAN; Model for inter network security-protection through cryptography - the role of cryptography in network security.

**Unit II: Automated Design and Network Management Tools**

Network design tools - network management protocols (CMISE/CMIP, SNMP, and RMON) - network management agents - the management station - network management implementation - web-based network management - other network management strategies.

**Unit III: Simple Network Management Protocol (SNMP)**

Introduction- concept of network management - change management - SNMP communities - structure of management information - SNMP operations - host management revisited - remote management revisited.

**Unit IV: SNMP adaptation**


**Unit V: Activities Based Learning**

Simulation: Secure data retrieval for decentralized disruption-tolerant networks, network traffic monitoring and windows remote manager, active source routing protocol for mobile networks using related software packages.
Reference Books:

Hyperlinks:
1. https://ns2blogger.blogspot.in/p/introduction-to-wired-topology.html

ECIS 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>ECIS 555</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** 9 Hours
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** 9 Hours
Unsupervised learning: Hierarchical clustering - graph theories approach to pattern clustering - fuzzy pattern classifier - application of pattern recognition in medicine.

**Unit III: Artificial Intelligence** 9 Hours

**Unit IV: Expert Systems** 9 Hours

**Unit V: Activities Based Learning** 9 Hours
Simulation of range images generation - extraction of geometric elements - automatic scene generation - scene recognition - geometrical hashing using related tools.
**Reference Books:**


**Hyperlinks:**


ECIS 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>ECIS 556</td>
<td>RADIATION SYSTEMS</td>
<td>L2 T1 P0</td>
<td>3</td>
<td>45</td>
</tr>
</tbody>
</table>

**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 - Friis 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

Huygen’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: Activities Based Learning**

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/

ECIS 556
<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>ECIS 557</td>
<td>SPEECH AND AUDIO PROCESSING</td>
<td>L 2 T 1 P 0</td>
<td>3</td>
<td>45</td>
</tr>
</tbody>
</table>

**Prerequisite:** Knowledge in signals and systems, digital signal processing, MATLAB

**Objective:** To impart the concepts of speech analysis using various methods, speech recognition and text-to-speech synthesis methods.

**Outcome:** Students will be able to understand the basic concepts of speech, different ways of analyzing the speech signals, applying processing techniques on speech signals.

**Unit I: Introduction**
Introduction to Phonetics and Phonology - models of speech production - ear physiology - psychoacoustics and speech perception; Basic audio processing: Normalization - audio processing – segmentation - analysis window sizing – visualization - sound generation.

**Unit II: Speech Analysis Methods**
Short-Time analysis: Short-Time energy and zero crossing rate - Short-Time Autocorrelation Function (STACF) - Short-Time Fourier Transform (STFT) - sampling STFT in time and frequency domain - speech spectrogram - Short-Time Fourier synthesis; Homomorphic analysis: Cepstrum and complex cepstrum - Short-Time cepstrum - cepstrum computation - Short-Time Homomorphic filtering of speech - application to pitch detection and pattern recognition.

**Unit III: Linear Predictive Analysis**
Linear prediction and speech model - computation of prediction coefficients - The Lenin-Durbin Recursion - LPC Spectrum - equivalent representation.

**Unit IV: Text-to-Speech Synthesis Methods and Automatic Speech Recognition**

**Unit V: Activities Based Learning**
Simulation on speech analysis, speech synthesis and speech recognition using related simulation tools.
**Reference Books:**

**Hyperlinks:**

ECIS 557
<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>ECIS 630</td>
<td>ADVANCED DISTRIBUTED SYSTEMS</td>
<td>L</td>
<td>T</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

**Prerequisite**: Fundamentals of Peer-to-Peer Systems and distributed Algorithms

**Objective**: To understand the fundamental principles and models underlying the theory, algorithms, and systems aspects of distributed systems.

**Outcome**: The students will be able to understand the fundamental principles and models underlying all aspects of distributed computing.

**Unit I: Introduction**

9 Hours

Definition - architectural models (client-server) - characteristics and challenges of distributed systems; Time: physical and logical time - event ordering - clock synchronization - message delivery ordering.

**Unit II: Communication**

9 Hours

Multithreaded clients and services - Virtualization and virtual machines - Code migration – RPC - Message and stream oriented communication - Multicast communication.

**Unit III: Synchronization and Naming**

9 Hours

Synchronization algorithms; Naming: Flat and structured naming- Attribute based naming; Consistency models and replica management.

**Unit IV: Fault Tolerance and Security**

9 Hours


**Unit V: Activities Based Learning**

9 Hours

Analyze the consistency properties of some existing system, either live or open source- Build a distributed storage system (or extend an existing one) that minimizes the amount of data.
Reference Books:
3. M.Sasikumar, et.al, “Introduction to Parallel Processing”, PHI, New Delhi, 2000

Hyperlinks:

ECIS 630
<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>ECIS 631</td>
<td>BIG DATA ANALYTICS</td>
<td>L 2 T 1 P 0</td>
<td>3</td>
<td>45</td>
</tr>
</tbody>
</table>

**Prerequisite:**  Basic concepts of Image processing and Machine learning

**Objective:** To explore the fundamental concepts of big data analytics and analyze the big data using intelligent techniques.

**Outcome:** The students will be able to understand the practical foundation level knowledge that enables them for immediate and effective participation in big data projects.

**Unit I: Introduction to Big Data** 9 Hours


**Unit II: Data Analysis** 9 Hours

Regression modeling - multivariate analysis - Bayesian modeling - inference and Bayesian networks - support vector and kernel methods; Neural networks: Learning and generalization - competitive learning - principal component analysis and neural networks; Fuzzy logic: Extracting fuzzy models from data - fuzzy decision trees.

**Unit III: Frequent Itemsets and Clustering** 9 Hours


**Unit IV: Frameworks and Visualization** 9 Hours

Map reduce - Hadoop, Hive, MapR - Sharding - NoSQL databases - S3 - Hadoop distributed file systems; Visualizations: Visual data analysis techniques; Interaction techniques: Systems and analytics applications - analytics using statistical packages.

**Unit V: Activities Based Learning** 9 Hours

Case Studies - Real Time Sentiment Analysis, Stock Market Predictions.
Reference Books:

Hyperlinks:
2. https://www.youtube.com/watch?v=aRReF-1vyPQ

ECIS 631
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Name of the Course</th>
<th>Periods</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECIS 632</td>
<td>CLOUD STORAGE AND COMPUTING</td>
<td>L T P</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 1 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>45</td>
</tr>
</tbody>
</table>

**Prerequisite:** Fundamentals of Networking and Distributed Computing

**Objective:** To understand the different deployment models of cloud and different services offered by cloud

**Outcome:** The students will be able to understand the basics of cloud, different services and security issues in cloud. In a nutshell, this course on cloud computing provides information on fundamental aspects of the cloud environment.

**Unit I: Introduction** 9 Hours

Cloud computing components - infrastructure-services - storage applications - database services – deployment models of cloud - services offered by cloud - benefits and limitations of cloud computing.

**Unit II: Virtualization Fundamentals** 9 Hours

Virtualization – enabling technology for cloud computing - types of virtualization - server virtualization - desktop virtualization – memory virtualization – application and storage virtualization - tools and products available for virtualization.

**Unit III: Software as a Service (SaaS) and Platform as a Service (PaaS)** 9 Hours

Getting started with SaaS - understanding the multitenant nature of SaaS solutions - understanding open SaaS solutions - understanding service oriented architecture - PaaS- benefits and limitations of PaaS.

**Unit IV: IaaS and Cloud Data Storage** 9 Hours

Understanding IaaS - improving performance through load balancing - server types within IaaS solutions- utilizing cloud based NAS devices – understanding cloud based data storage - cloud based backup devices - cloud based database solutions - cloud based block storage.

**Unit V: Activities Based Learning** 9 Hours

Client side programming model: Web clients - mobile clients; Server side programming Technologies: AJAX, JSON, web services (RPC, REST) using related simulation tools.
Reference Books:

Hyperlinks:

ECIS 632
<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>ECIS 633</td>
<td>COGNITIVE RADIO</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: Activities Based Learning** 9 Hours
Simulation of CR & SDC network using related tools.
Reference Books:

Hyperlinks:

ECIS 633
<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>ECIS 634</td>
<td>CONVERGENCE TECHNOLOGIES</td>
<td>L T P</td>
<td>2 1 0</td>
<td>3 45</td>
</tr>
</tbody>
</table>

**Prerequisite**: Basics of wireless networks, elementary concepts in probability, optimization related to communication systems.

**Objective**: To familiarize 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**  
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: Activities Based Learning**  
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/

ECIS 634
Prerequisite: Fundamentals of Relay networks and communication systems.

Objective: To provide an intuitive understanding of the practical use of cooperative communications.

Outcome: Students will be able to understand the basics of cooperative communication.

Unit I: Introduction
9 Hours
Cooperative communications - cooperation protocols - hierarchical cooperation; Cooperative Communications with single relay; Multi-node cooperative communications.

Unit II: Distributed Space Time and Space Frequency Coding
9 Hours
Distributed space-time coding (DSTC); Distributed Space-Frequency Coding (DSFC); Relay selection; Differential modulations for DF cooperative communications - AF cooperative communications.

Unit III: Cooperative Multiple Access and Routing
9 Hours
Cooperative multiple access - System model; Content-aware cooperative multiple access protocol distributed cooperative routing - network model; cooperation based routing protocol source - channel coding with cooperation.

Unit IV: Broadband Cooperative Communications
9 Hours
Broadband cooperative communications - system model - cooperative protocol and relay assignment scheme - performance analysis; Network lifetime maximization via cooperation - system models - lifetime maximization by employing a cooperative node - deploying relays to improve device lifetime.

Unit V: Activities Based Learning
9 Hours
Experimental implementation of relaying platforms - cooperative spatial modulation systems - performance evaluation of cooperative communications with channel coding and modulation techniques using related simulation tools.
Reference Books:

Hyperlinks:
2. https://engagedscholarship.csuohio.edu/cgi/viewcontent.cgi?article=1791&context=etdarchive

ECIS 635
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: Activities Based Learning 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:

ECIS 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>ECIS 637</td>
<td>GREEN RADIO COMMUNICATION NETWORKS</td>
<td>L 2</td>
<td>T 1</td>
<td>P 0</td>
</tr>
</tbody>
</table>

**Prerequisite:** Fundamentals of electronics, communication and wireless networks.

**Objective:** To impart the importance of reducing energy consumption, CO2 emissions and inculcate green concepts for energy efficient approaches while designing next generation wireless networks.

**Outcome:** Students can design new green radio architectures and radio techniques to reduce the overall energy consumption.

**Unit I: Introduction** 9 Hours

**Unit II: Green Modulation and Coding** 9 Hours
Modulation: Green modulation and coding schemes in energy constrained wireless networks - energy consumption of uncoded scheme - energy consumption analysis of LT coded modulation.

**Unit III: Co-operative Techniques** 9 Hours
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 IV: Energy Saving Technologies for Green Radio Networks** 9 Hours
Network energy saving technologies for green wireless access networks- cell wilting and blossoming for energy efficiency - dimensioning network deployment and resource management in green mesh networks

**Unit V: Activities Based Learning** 9 Hours
Energy consumption analysis of uncoded schemes (M-ary FSK, M-ary QAM) and LT coded modulation schemes.
**Reference Books:**


**Hyperlinks:**


ECIS 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>ECIS 638</td>
<td>INTERNET OF EVERY THING (IoET)</td>
<td>L 2, T 1, P 0</td>
<td>3</td>
<td>45</td>
</tr>
</tbody>
</table>

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

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

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

**Unit I: Introduction**


**Unit II: IoET Sensors**

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

**Unit III: IoET Security**

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

**Unit IV: IoET Testbed**

ACOEM Eagle - EnOcean push button - NEST sensor - Ninja blocks focus on wearable electronics.

**Unit V: Activities Based Learning**

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/

ECIS 638
<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>ECIS 639</td>
<td>LOW POWER DIGITAL VLSI DESIGN</td>
<td>L 2 T 1 P 0</td>
<td>3</td>
<td>45</td>
</tr>
</tbody>
</table>

Prerequisite: Fundamentals of VLSI design.

Objective: To understand the 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

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

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

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; RAM.

Unit IV: Energy Recovery Techniques

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: Activities Based Learning

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/

ECIS 639
<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>ECIS 640</td>
<td>REAL TIME OPERATING SYSTEM</td>
<td>L 2</td>
<td>T 1</td>
<td>P 0</td>
</tr>
</tbody>
</table>

**Prerequisite:** Basics of operating systems and C-Programming.

**Objective:** To make the students to develop software for embedded computer system using Real-Time Operating System.

**Outcome:** Students will be able to design real time embedded systems using the concepts of RTOS and also recognize the classification of embedded systems.

**Unit I: Introduction to Operating Systems** 9 Hours
Basic principles - system calls - files - processes - design and implementation of processes - communication between processes - operating system structures.

**Unit II: Distributed Operating Systems** 9 Hours
Topology - network types - communication - RPC - client server model - distributed file system design.

**Unit III: Real Time Operating System** 9 Hours

**Unit IV: RTOS Kernel Topics** 9 Hours
Principles - design issues - polled loop systems - RTOS porting to a target - comparison and study of RTOS VX works and μCOS - dynamic memory allocation - fragmentation issues - RTOS timers - relative and absolute timing - asynchronous signals - device I/O supervisor.

**Unit V: Activities Based Learning** 9 Hours
Case Studies on RTOS for image processing - embedded RTOS for voice over IP - RTOS for fault tolerant applications - RTOS for control systems.
Reference Books:

Hyperlinks:

ECIS 640
<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>ECIS 641</td>
<td>SENSORS AND ACTUATORS</td>
<td>L 2 T 1 P 0</td>
<td>3</td>
<td>45</td>
</tr>
</tbody>
</table>

**Prerequisite:** Measurements and Instruments.

**Objective:** To make the students to understand basic laws and phenomena on operation of sensors and actuators-transformation of energy.

**Outcome:** Students will able to analyze various premises, approaches, procedures and performance related to sensors and actuators.

**Unit I: Sensors / Transducers**
9 Hours

**Unit II: Thermal Sensors**
9 Hours

**Unit III: Radiation Sensors**
9 Hours
Introduction - basic characteristics - types of photosensistors/photo detectors - x-ray and nuclear radiation sensors - fiber optic sensors; Electro analytical sensors: The electrochemical cell - the cell potential - standard hydrogen electrode (she) - liquid junction and other potentials - polarization - concentration polarization - reference electrodes - sensor electrodes - electro ceramics in gas media.

**Unit IV: Actuators**
9 Hours

**Unit V: Activities Based Learning**
9 Hours
Design and analysis of sensors and actuators for various applications using related simulation tools.
Reference Books:

Hyperlinks:

ECIS 641
<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>ECIS 642</td>
<td>SOFT COMPUTING</td>
<td>L 2  T 1  P 0</td>
<td>3</td>
<td>45</td>
</tr>
</tbody>
</table>

**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: Activities Based Learning**

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


Hyperlinks:


ECIS 642
<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>ECIS 643</td>
<td>VEHICULAR AD-HOC NETWORKS (VANET)</td>
<td>L 2 T 1 P 0</td>
<td>3</td>
<td>45</td>
</tr>
</tbody>
</table>

**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- enabling technologies - DSRC regulations and standard - 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: Activities Based Learning**  
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/

ECIS 643

*****