

**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**

**B.Tech. in COMPUTER AND COMMUNICATION ENGINEERING**  
**(BTC-CCE)**

**CURRICULUM AND SYLLABI**  
**(2019)**

## GENERAL INFORMATION

### ABBREVIATIONS USED IN THE CURRICULUM

|      |   |  |
|------|---|--|
| Cat  | - | Category   |
| L    | - | Lecture  |
| T    | - | Tutorial   |
| P    | - | Practical  |
| Cr   | - | Credits  |
| ENGG | - | Engineering Sciences (including General, Core and Electives) |
| HUM  | - | Humanities (including Languages and others)                  |
| SCI  | - | Basic Sciences (including Mathematics)                       |
| PRJ  | - | Project Work (including Seminars)                            |
|      |   |  |
| AES  | - | Aerospace Engineering  |
| AIE  | - | Computer Science and Engineering - Artificial Intelligence   |
| BIO  | - | Biology  |
| CCE  | - | Computer and Communication Engineering                       |
| CHE  | - | Chemical Engineering   |
| CHY  | - | Chemistry  |
| CSE  | - | Computer Science and Engineering                             |
| CVL  | - | Civil Engineering  |
| CUL  | - | Cultural Education   |
| EAC  | - | Electronics and Computer Engineering                         |
| ECE  | - | Electronics and Communication Engineering                    |
| EEE  | - | Electrical and Electronics Engineering                       |
| ELC  | - | Electrical and Computer Engineering                          |
| HUM  | - | Humanities   |
| MAT  | - | Mathematics  |
| MEE  | - | Mechanical Engineering                                       |
| PHY  | - | Physics  |

**Course Outcome (CO)** – Statements that describe what students are expected to know, and are able to do at the end of each course. These relate to the skills, knowledge and behaviour that students acquire in their progress through the course.

**Program Outcomes (POs)** – Program Outcomes are statements that describe what students are expected to know and be able to do upon graduating from the Program. These relate to the skills, knowledge, attitude and behaviour that students acquire through the program. NBA has defined the Program Outcomes for each discipline.

### PROGRAM OUTCOMES FOR ENGINEERING

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**SEMESTER I**

| <b>Cat.</b> | <b>Code</b> | <b>Title</b>                                     | <b>L T P</b> | <b>Credit</b> |
|-------------|-------------|--|--------------|---------------|
| SCI         | 19BIO101    | Biology for Engineers - A                        | 3 0 0        | 3             |
| SCI         | 19MAT101    | Single Variable Calculus                         | 1 0 0        | 1             |
| SCI         | 19MAT102    | Matrix Algebra                                   | 2 0 0        | 2             |
| ENGG        | 19CSE100    | Problem Solving and Algorithmic Thinking         | 2 1 3        | 4             |
| SCI         | 19PHY103    | Physics of Electronic Materials                  | 3 0 0        | 3             |
| ENGG        | 19MEE100    | Engineering Graphics - CAD                       | 2 0 3        | 3             |
| ENGG        | 19EEE100    | Basic Electrical and Electronics Engineering     | 3 0 0        | 3             |
| ENGG        | 19EEE181    | Basic Electrical and Electronics Engineering Lab | 0 0 3        | 1             |
| ENGG        | 19ECE101    | Introduction to Internet of Things               | 0 0 3        | 1             |
| HUM         | 19CUL101    | Cultural Education - I                           | 2 0 0        | 2             |
|             |             | <b>TOTAL</b>                                     |              | <b>23</b>     |

**SEMESTER II**

| <b>Cat.</b> | <b>Code</b> | <b>Title</b>                  | <b>L T P</b> | <b>Credit</b> |
|-------------|-------------|-------------------------------|--------------|---------------|
| HUM         | 19ENG111    | Technical Communication       | 2 0 3        | 3             |
| SCI         | 19MAT111    | Multivariable Calculus        | 2 0 0        | 2             |
| SCI         | 19MAT112    | Linear Algebra                | 2 1 0        | 3             |
| SCI         | 19CHY102    | Engineering Chemistry - B     | 2 1 0        | 3             |
| SCI         | 19CHY182    | Engineering Chemistry Lab - B | 0 0 3        | 1             |
| ENGG        | 19CSE102    | Computer Programming          | 3 0 3        | 4             |
| ENGG        | 19CCE111    | Digital Design                | 3 1 0        | 4             |
| ENGG        | 19CCE181    | Digital Design Lab            | 0 0 3        | 1             |
| ENGG        | 19MEE181    | Manufacturing Practice        | 0 0 3        | 1             |
| ENGG        | 19ECE181    | Electronic Systems Lab        | 0 0 3        | 1             |
| HUM         | 19CUL111    | Cultural Education - II       | 2 0 0        | 2             |
|             |             | <b>TOTAL</b>                  |              | <b>25</b>     |

**SEMESTER III**

| Cat. | Code     | Title                                       | L T P     | Credit    |
|------|----------|---|-----------|-----------|
| ENGG | 19CCE201 | Microcontrollers and Interfacing Techniques | 3 0 3     | 4         |
| ENGG | 19CCE202 | Data Structures and Algorithms              | 3 0 0     | 3         |
| ENGG | 19CCE203 | Computational Electromagnetics              | 3 0 3     | 4         |
| ENGG | 19CCE204 | Signal Processing                           | 3 1 0     | 4         |
| SCI  | 19MAT205 | Probability Theory and Random Processes     | 3 1 0     | 4         |
| ENGG | 19CCE281 | Signal Processing Lab                       | 0 0 3     | 1         |
| ENGG | 19CCE282 | Data Structures Lab                         | 0 0 3     | 1         |
| HUM  | 19ENV300 | Environmental Science                       |           | P/F       |
|      |          | <b>TOTAL</b>                                | <b>29</b> | <b>21</b> |

**SEMESTER IV**

| Cat. | Code     | Title   | L T P     | Credit    |
|------|----------|---|-----------|-----------|
| ENGG | 19CCE211 | Embedded Computing                                    | 3 0 0     | 3         |
| ENGG | 19CCE212 | Multi rate Signal Processing & Software Defined Radio | 3 0 0     | 3         |
| ENGG | 19CCE213 | Machine Learning and Artificial Intelligence          | 3 0 3     | 4         |
| ENGG | 19CCE214 | Analog Communication Theory                           | 3 1 0     | 4         |
| SCI  | 19MAT213 | Optimization Techniques                               | 3 0 0     | 3         |
| ENGG | 19CCE283 | Embedded Computing Lab                                | 0 0 3     | 1         |
| ENGG | 19CCE284 | Software Defined Radio Lab                            | 0 0 3     | 1         |
| HUM  | 19SSK211 | Soft Skills I   | 1 0 3     | 2         |
| HUM  | 19LAW300 | Indian Constitution                                   |           | P/F       |
|      |          | <b>TOTAL</b>  | <b>29</b> | <b>21</b> |

**SEMESTER V**

| <b>Cat.</b> | <b>Code</b>     | <b>Title</b>                             | <b>L T P</b> | <b>Credit</b> |
|-------------|-----------------|--|--------------|---------------|
| <b>ENGG</b> | <b>19CCE301</b> | <b>Internet of Things</b>                | <b>3 0 0</b> | <b>3</b>      |
| <b>ENGG</b> | <b>19CCE303</b> | <b>Digital Communication</b>             | <b>3 1 0</b> | <b>4</b>      |
| <b>ENGG</b> | <b>19CCE304</b> | <b>Computer Networks</b>                 | <b>3 0 3</b> | <b>4</b>      |
| <b>ENGG</b> | <b>19CCE302</b> | <b>Computer Systems and Architecture</b> | <b>3 0 0</b> | <b>3</b>      |
| <b>ENGG</b> |                 | <b>Professional Elective I*</b>          | <b>3 0 0</b> | <b>3</b>      |
| <b>ENGG</b> | <b>19CCE391</b> | <b>Seminar</b>                           | <b>0 0 3</b> | <b>1</b>      |
| <b>ENGG</b> | <b>19CCE381</b> | <b>IoT and Computing Lab</b>             | <b>0 0 3</b> | <b>1</b>      |
| <b>ENGG</b> | <b>19CCE382</b> | <b>Communication Systems Design Lab</b>  | <b>0 0 3</b> | <b>1</b>      |
| <b>HUM</b>  | <b>19SSK301</b> | <b>Soft Skills II</b>                    | <b>1 0 3</b> | <b>2</b>      |
| <b>ENGG</b> | <b>19LIV390</b> | <b>Live-in –Labs***</b>                  |              | <b>[3]</b>    |
|             |                 | <b>TOTAL</b>                             | <b>32</b>    | <b>22</b>     |

**SEMESTER VI**

| <b>Cat.</b> | <b>Code</b>     | <b>Title</b>   | <b>L T P</b> | <b>Credit</b> |
|-------------|-----------------|--|--------------|---------------|
| <b>ENGG</b> | <b>19CCE311</b> | <b>Wireless Communication</b>                                  | <b>3 1 0</b> | <b>4</b>      |
| <b>ENGG</b> | <b>19CCE312</b> | <b>Cyber-Physical Systems: Design, Modeling and Simulation</b> | <b>3 0 3</b> | <b>4</b>      |
| <b>ENGG</b> | <b>19CCE313</b> | <b>RF System Design</b>  | <b>3 0 0</b> | <b>3</b>      |
| <b>ENGG</b> |                 | <b>Professional Elective II*</b>                               | <b>3 0 0</b> | <b>3</b>      |
| <b>ENGG</b> |                 | <b>Professional Elective III*</b>                              | <b>3 0 0</b> | <b>3</b>      |
| <b>ENGG</b> | <b>19CCE383</b> | <b>Electromagnetic Simulation Lab</b>                          | <b>0 0 3</b> | <b>1</b>      |
| <b>ENGG</b> | <b>19CCE384</b> | <b>Design and Innovation Lab</b>                               | <b>0 0 3</b> | <b>1</b>      |
| <b>HUM</b>  | <b>19SSK311</b> | <b>Soft Skills III</b>   | <b>1 0 3</b> | <b>2</b>      |
| <b>ENGG</b> | <b>19LIV490</b> | <b>Live-in –Labs***</b>  |              | <b>[3]</b>    |
| <b>HUM</b>  | <b>19MNG300</b> | <b>Disaster Management</b>                                     |              | <b>P/F</b>    |

|  |  |              |           |           |
|--|--|--------------|-----------|-----------|
|  |  | <b>TOTAL</b> | <b>29</b> | <b>21</b> |
|--|--|--------------|-----------|-----------|

### SEMESTER VII

| Cat. | Code     | Title                     | L T P     | Credit    |
|------|----------|---------------------------|-----------|-----------|
| ENGG |          | Professional Elective IV* | 3 0 0     | 3         |
| ENGG |          | Professional Elective V*  | 3 0 0     | 3         |
| ENGG |          | Professional Elective VI* | 3 0 0     | 3         |
| HUM  |          | Free Elective**           | 2 0 0     | 2         |
| HUM  |          | Free Elective**           | 2 0 0     | 2         |
| PRJ  | 19CCE495 | Project Phase I           | 0 0 6     | 2         |
|      |          | <b>TOTAL</b>              | <b>19</b> | <b>15</b> |

### SEMESTER VIII

| Cat. | Code     | Title                      | L T P     | Credit    |
|------|----------|----------------------------|-----------|-----------|
| ENGG |          | Professional Elective VII* | 3 0 0     | 3         |
| PRJ  | 19CCE499 | Project Phase II           | 0 0 30    | 10        |
|      |          | <b>TOTAL</b>               | <b>33</b> | <b>13</b> |

|  |  |                      |  |            |
|--|--|----------------------|--|------------|
|  |  | <b>TOTAL CREDITS</b> |  | <b>161</b> |
|--|--|----------------------|--|------------|

**\*Professional Elective** - Electives categorised under Engineering, Science, Mathematics, Live-in-Labs, and NPTEL Courses. Student can opt for such electives across departments/campuses. Students with CGPA of 7.0 and above can opt for a maximum of 2 NPTEL courses with the credits not exceeding 8.

**\*\* Free Electives** - This will include courses offered by Faculty of Humanities and Social Sciences/ Faculty Arts, Commerce and Media / Faculty of Management/Amrita Darshanam -(International Centre for Spiritual Studies).

**\*\*\* Live-in-Labs** - Students undertaking and registering for a Live-in-Labs project, can be exempted from registering for an Elective course in the higher semester.

## PROFESSIONAL ELECTIVES

| Cat.                             | Code     | Title  | L T P | Credit |
|----------------------------------|----------|--|-------|--------|
| <b>Computational Engineering</b> |          |  |       |        |
| ENGG                             | 19CCE331 | Markov Process and Queuing Theory              | 3 0 0 | 3      |
| ENGG                             | 19CCE332 | Operations Research                            | 3 0 0 | 3      |
| ENGG                             | 19CCE333 | Convex Optimization                            | 3 0 0 | 3      |
| ENGG                             | 19CCE334 | Deep Learning                                  | 3 0 0 | 3      |
| ENGG                             | 19CCE335 | Bio-inspired Algorithms                        | 3 0 0 | 3      |
| ENGG                             | 19CCE336 | Game Theory                                    | 3 0 0 | 3      |
| ENGG                             | 19CCE337 | Pattern Recognition                            | 3 0 0 | 3      |
| ENGG                             | 19CCE338 | Signal Processing for Business Applications    | 3 0 0 | 3      |
| ENGG                             | 19CCE339 | Non-linear Dynamics and Chaos                  | 3 0 0 | 3      |
| ENGG                             | 19CCE340 | Agent Based Modeling                           | 3 0 0 | 3      |
| ENGG                             | 19CCE341 | Robotics                                       | 3 0 0 | 3      |
| <b>Communication Engineering</b> |          |  |       |        |
| ENGG                             | 19CCE431 | Software Defined Networks                      | 3 0 0 | 3      |
| ENGG                             | 19CCE432 | Orthogonal Frequency Division Multiplexing     | 3 0 0 | 3      |
| ENGG                             | 19CCE433 | Multiple Input Multiple Output Communication   | 3 0 0 | 3      |
| ENGG                             | 19CCE434 | Spread Spectrum Communication                  | 3 0 0 | 3      |
| ENGG                             | 19CCE435 | Wireless Sensor Networks                       | 3 0 0 | 3      |
| ENGG                             | 19CCE436 | Mobile Communication                           | 3 0 0 | 3      |
| ENGG                             | 19CCE437 | Vehicular Communication                        | 3 0 0 | 3      |
| ENGG                             | 19CCE438 | Millimeter Wave Personal Communication Systems | 3 0 0 | 3      |
| ENGG                             | 19CCE439 | Telecommunication Management                   | 3 0 0 | 3      |
| ENGG                             | 19CCE440 | Avionics                                       | 3 0 0 | 3      |
| ENGG                             | 19CCE441 | Antenna Systems                                | 3 0 0 | 3      |
| ENGG                             | 19CCE442 | Planar Microwave Devices                       | 3 0 0 | 3      |
| ENGG                             | 19CCE443 | Satellite Communication                        | 3 0 0 | 3      |
| ENGG                             | 19CCE444 | Spoken Language Processing                     | 3 0 0 | 3      |
| ENGG                             | 19CCE445 | Radar Signal Processing                        | 3 0 0 | 3      |
| ENGG                             | 19CCE446 | Statistical Signal Processing                  | 3 0 0 | 3      |
| ENGG                             | 19CCE447 | Image Processing                               | 3 0 0 | 3      |
| ENGG                             | 19CCE448 | Biomedical Signal Processing                   | 3 0 0 | 3      |
| ENGG                             | 19CCE449 | Hyperspectral Image Analysis                   | 3 0 0 | 3      |



|      |          |                            |       |   |
|------|----------|----------------------------|-------|---|
| ENGG | 19CCE450 | Wavelets and Application   | 3 0 0 | 3 |
| ENGG | 19CCE451 | Adaptive Signal Processing | 3 0 0 | 3 |

| <b>Computer Science Engineering</b> |          |   |       |   |
|-------------------------------------|----------|---|-------|---|
| ENGG                                | 19CSE471 | Principles of Operating Systems           | 3 0 0 | 3 |
| ENGG                                | 19CSE472 | Mobile Application Development            | 3 0 0 | 3 |
| ENGG                                | 19CSE473 | Fundamentals of Software Engineering      | 3 0 0 | 3 |
| ENGG                                | 19CSE474 | Introduction to Big Data Analytics        | 3 0 0 | 3 |
| ENGG                                | 19CSE475 | Foundation of Information Technology      | 3 0 0 | 3 |
| ENGG                                | 19CSE476 | Principles of Database Management Systems | 3 0 0 | 3 |
| ENGG                                | 19CSE477 | Principles of Computer Networks           | 3 0 0 | 3 |
| ENGG                                | 19CSE478 | Advanced Programming                      | 3 0 0 | 3 |
| ENGG                                | 19CSE479 | Object Oriented Paradigm                  | 3 0 0 | 3 |

#### PROFESSIONAL ELECTIVES UNDER SCIENCE STREAM

| <b>CHEMISTRY</b> |             |   |              |               |
|------------------|-------------|---|--------------|---------------|
| <b>Cat.</b>      | <b>Code</b> | <b>Title</b>                                    | <b>L T P</b> | <b>Credit</b> |
| SCI              | 19CHY243    | Computational Chemistry and Molecular Modelling | 3 0 0        | 3             |
| SCI              | 19CHY236    | Electrochemical Energy Systems and Processes    | 3 0 0        | 3             |
| SCI              | 19CHY240    | Fuels and Combustion                            | 3 0 0        | 3             |
| SCI              | 19CHY232    | Green Chemistry and Technology                  | 3 0 0        | 3             |
| SCI              | 19CHY239    | Instrumental Methods of Analysis                | 3 0 0        | 3             |
| SCI              | 19CHY241    | Batteries and Fuel Cells                        | 3 0 0        | 3             |
| SCI              | 19CHY242    | Corrosion Science                               | 3 0 0        | 3             |
| <b>PHYSICS</b>   |             |   |              |               |
| SCI              | 19PHY340    | Advanced Classical Dynamics                     | 3 0 0        | 3             |

|                    |          |  |       |   |
|--------------------|----------|--|-------|---|
| SCI                | 19PHY342 | Electrical Engineering Materials           | 3 0 0 | 3 |
| SCI                | 19PHY331 | Physics of Lasers and Applications         | 3 0 0 | 3 |
| SCI                | 19PHY341 | Concepts of Nanophysics and Nanotechnology | 3 0 0 | 3 |
| SCI                | 19PHY343 | Physics of Semiconductor Devices           | 3 0 0 | 3 |
| SCI                | 19PHY339 | Astrophysics                               | 3 0 0 | 3 |
| <b>MATHEMATICS</b> |          |  |       |   |
| SCI                | 19MAT341 | Statistical Inference                      | 3 0 0 | 3 |
| SCI                | 19MAT342 | Introduction to Game Theory                | 3 0 0 | 3 |
| SCI                | 19MAT343 | Numerical Methods and Optimization         | 3 0 0 | 3 |

### FREE ELECTIVES

| <b>FREE ELECTIVES OFFERED UNDER MANAGEMENT STREAM</b> |          |                               |       |        |
|---|----------|-------------------------------|-------|--------|
| Cat.  | Code     | Title                         | L T P | Credit |
| HUM   | 19MNG331 | Financial Management          | 3 0 0 | 3      |
| HUM   | 19MNG332 | Supply Chain Management       | 3 0 0 | 3      |
| HUM   | 19MNG333 | Marketing Management          | 3 0 0 | 3      |
| HUM   | 19MNG334 | Project Management            | 3 0 0 | 3      |
| HUM   | 19MNG335 | Enterprise Management         | 3 0 0 | 3      |
| HUM   | 19MNG338 | Operations Research           | 3 0 0 | 3      |
| HUM   | 19MEE401 | Industrial Engineering        | 3 0 0 | 3      |
| HUM   | 19MEE346 | Managerial Statistics         | 3 0 0 | 3      |
| HUM   | 19MEE347 | Total Quality Management      | 3 0 0 | 3      |
| HUM   | 19MEE342 | Lean Manufacturing            | 3 0 0 | 3      |
| HUM   | 19CSE358 | Software Project Management   | 3 0 0 | 3      |
| HUM   | 19CSE359 | Financial Engineering         | 3 0 0 | 3      |
| HUM   | 19CSE360 | Engineering Economic Analysis | 3 0 0 | 3      |
| HUM   | 19MNG331 | Financial Management          | 3 0 0 | 3      |

|            |                 |                            |              |          |
|------------|-----------------|----------------------------|--------------|----------|
| <b>HUM</b> | <b>19CSE362</b> | <b>Information Systems</b> | <b>3 0 0</b> | <b>3</b> |
|------------|-----------------|----------------------------|--------------|----------|

| <b>FREE ELECTIVES OFFERED UNDER HUMANITIES / SOCIAL SCIENCE STREAMS</b> |                 |   |              |               |
|---|-----------------|---|--------------|---------------|
| <b>Cat.</b>   | <b>Code</b>     | <b>Title</b>  | <b>L T P</b> | <b>Credit</b> |
| <b>HUM</b>  | <b>19CUL230</b> | <b>Achieving Excellence in Life - An Indian Perspective</b>       | <b>2 0 0</b> | <b>2</b>      |
| <b>HUM</b>  | <b>19CUL231</b> | <b>Excellence in Daily Life</b>                                   | <b>2 0 0</b> | <b>2</b>      |
| <b>HUM</b>  | <b>19CUL232</b> | <b>Exploring Science and Technology in Ancient India</b>          | <b>2 0 0</b> | <b>2</b>      |
| <b>HUM</b>  | <b>19CUL233</b> | <b>Yoga Psychology</b>  | <b>2 0 0</b> | <b>2</b>      |
| <b>HUM</b>  | <b>19ENG230</b> | <b>Business Communication</b>                                     | <b>1 0 3</b> | <b>2</b>      |
| <b>HUM</b>  | <b>19ENG231</b> | <b>Indian Thought through English</b>                             | <b>2 0 0</b> | <b>2</b>      |
| <b>HUM</b>  | <b>19ENG232</b> | <b>Insights into Life through English Literature</b>              | <b>2 0 0</b> | <b>2</b>      |
| <b>HUM</b>  | <b>19ENG233</b> | <b>Technical Communication</b>                                    | <b>2 0 0</b> | <b>2</b>      |
| <b>HUM</b>  | <b>19ENG234</b> | <b>Indian Short Stories in English</b>                            | <b>2 0 0</b> | <b>2</b>      |
| <b>HUM</b>  | <b>19FRE230</b> | <b>Proficiency in French Language (Lower)</b>                     | <b>2 0 0</b> | <b>2</b>      |
| <b>HUM</b>  | <b>19FRE231</b> | <b>Proficiency in French Language (Higher)</b>                    | <b>2 0 0</b> | <b>2</b>      |
| <b>HUM</b>  | <b>19GER230</b> | <b>German for Beginners I</b>                                     | <b>2 0 0</b> | <b>2</b>      |
| <b>HUM</b>  | <b>19GER231</b> | <b>German for Beginners II</b>                                    | <b>2 0 0</b> | <b>2</b>      |
| <b>HUM</b>  | <b>19GER232</b> | <b>Proficiency in German Language (Lower)</b>                     | <b>2 0 0</b> | <b>2</b>      |
| <b>HUM</b>  | <b>19GER233</b> | <b>Proficiency in German Language (Higher)</b>                    | <b>2 0 0</b> | <b>2</b>      |
| <b>HUM</b>  | <b>19HIN101</b> | <b>Hindi I</b>  | <b>2 0 0</b> | <b>2</b>      |
| <b>HUM</b>  | <b>19HIN111</b> | <b>Hindi II</b>   | <b>2 0 0</b> | <b>2</b>      |
| <b>HUM</b>  | <b>19HUM230</b> | <b>Emotional Intelligence</b>                                     | <b>2 0 0</b> | <b>2</b>      |
| <b>HUM</b>  | <b>19HUM231</b> | <b>Glimpses into the Indian Mind - the Growth of Modern India</b> | <b>2 0 0</b> | <b>2</b>      |
| <b>HUM</b>  | <b>19HUM232</b> | <b>Glimpses of Eternal India</b>                                  | <b>2 0 0</b> | <b>2</b>      |
| <b>HUM</b>  | <b>19HUM233</b> | <b>Glimpses of Indian Economy and Polity</b>                      | <b>2 0 0</b> | <b>2</b>      |
| <b>HUM</b>  | <b>19HUM234</b> | <b>Health and Lifestyle</b>                                       | <b>2 0 0</b> | <b>2</b>      |

|     |           |  |       |   |
|-----|-----------|--|-------|---|
| HUM | 19HUM235  | Indian Classics for the Twenty-first Century     | 2 0 0 | 2 |
| HUM | 19HUM236  | Introduction to India Studies                    | 2 0 0 | 2 |
| HUM | 19HUM237  | Introduction to Sanskrit Language and Literature | 2 0 0 | 2 |
| HUM | 19HUM238  | National Service Scheme                          | 2 0 0 | 2 |
| HUM | 19HUM239  | Psychology for Effective Living                  | 2 0 0 | 2 |
| HUM | 19HUM240  | Psychology for Engineers                         | 2 0 0 | 2 |
| HUM | 19HUM241  | Science and Society - An Indian Perspective      | 2 0 0 | 2 |
| HUM | 19HUM242  | The Message of Bhagwad Gita                      | 2 0 0 | 2 |
| HUM | 19HUM243  | The Message of the Upanishads                    | 2 0 0 | 2 |
| HUM | 19HUM244  | Understanding Science of Food and Nutrition      | 2 0 0 | 2 |
| HUM | 19JAP230  | Proficiency in Japanese Language (Lower)         | 2 0 0 | 2 |
| HUM | 19JAP2313 | Proficiency in Japanese Language (Higher)        | 2 0 0 | 2 |
| HUM | 19KAN101  | Kannada I  | 2 0 0 | 2 |
| HUM | 19KAN111  | Kannada II                                       | 2 0 0 | 2 |
| HUM | 19MAL101  | Malayalam I                                      | 2 0 0 | 2 |
| HUM | 19MAL111  | Malayalam II                                     | 2 0 0 | 2 |
| HUM | 19SAN101  | Sanskrit I                                       | 2 0 0 | 2 |
| HUM | 19SAN111  | Sanskrit II                                      | 2 0 0 | 2 |
| HUM | 19SWK230  | Corporate Social Responsibility                  | 2 0 0 | 2 |
| HUM | 19SWK231  | Workplace Mental Health                          | 2 0 0 | 2 |
| HUM | 19TAM101  | Tamil I  | 2 0 0 | 2 |
| HUM | 19TAM111  | Tamil II   | 2 0 0 | 2 |

# SYLLABUS

## SEMESTER I

19BIO101

BIOLOGY FOR ENGINEERS - A

L-T-P-C: 3-0-0-3

**Pre Requisite(s):** Nil

### Course Objectives

- To understand Biological concepts from an engineering perspective
- To understand the inter-connection between biology and future technologies
- To motivate technology application for biological and life science challenges

### Course Outcomes

**CO1:** Understand the biological concepts from an engineering perspective

**CO2:** Understand the concepts of biological sensing and its challenges

**CO3:** Understand development of artificial systems mimicking human action

**CO4:** Integrate biological principles for developing next generation technologies

### CO-PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 2    | 2    |
| CO2    | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 2    | 2    |
| CO3    | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 2    | 2    |
| CO4    | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 2    | 2    |

### Syllabus

#### Unit 1

Need to study Biology – Life Science Studies Significance - Bio Inspired Inventions - Role of Biology in Next Generation Technology Development – Cell Structure – Cell Potential - Action Potential – ECG and other common signals – Sodium Potassium Channels – Neuron function – Central Nervous Systems – Discussion Topics - Evolution of Artificial Neural Networks - Machine Learning Techniques.

#### Unit 2

Sensing Techniques - Understanding of Sense organs working – Sensing mechanisms - Sensor Development issues – Discussion Topics -Digital Camera – Eye Comparison - Electronic nose -Electronic tongue -Electronic skin.

#### Unit 3

Physiological Assist Device -Artificial Organ Development - Kidney – Liver – Pancreas - heart valves – Design Challenges and Technological Developments.

**Text Book(s)**

Leslie Cromwell, "Biomedical Instrumentation", Prentice Hall 2011.

Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj R. W., Barathi S., and Jaganthan M.K., "Biology for Engineers", Tata McGraw-Hill, New Delhi, 2012.

**Reference(s)**

<https://www.sciencedirect.com/topics/medicine-and-dentistry/electronic-nose>.

<https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/electronic-tongue>.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.

**Course Objectives**

- Understand the various functions and their graphs.
- Understand the basic concept of continuous function and find the extreme values of the continuous functions.
- Understand the definite integral and various integration techniques.

**Course Outcomes**

**CO1:** To understand the concepts of single variable calculus.

**CO2:** To sketch graphs for functions using the concepts of single variable calculus and apply the fundamental theorem of calculus to evaluate integrals.

**CO-PO Mapping**

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 1   | 3   | --- | --- | --- | --- | --- | --- | --- | ---  | ---  | ---  |      |      |
| CO2    | 1   | 2   | --- | --- | 2   | --- | --- | --- | --- | ---  | ---  | ---  |      |      |

**Syllabus****Unit 1**

Calculus

Graphs: Functions and their Graphs. Shifting and Scaling of Graphs. (1.5)

**Unit 2**

Limit and Continuity: Limit (One Sided and Two Sided) of Functions. Continuous Functions, Discontinuities, Monotonic Functions, Infinite Limits and Limit at Infinity. (2.1, 2.6)

**Unit 3**

Graphing : Extreme Values of Functions, Concavity and Curve Sketching, (4.1, 4.4).

**Unit 4**

Integration: Definite Integrals, The Mean Value Theorem for definite integrals, Fundamental Theorem of Calculus, Integration Techniques. (5.2 - 5.3, 8.1 – 8.5)

**Text Book**

*Calculus*, G.B. Thomas Pearson Education, 2009, Eleventh Edition.

**Reference**

*Calculus*, Monty J. Strauss, Gerald J. Bradley and Karl J. Smith, 3<sup>rd</sup> Edition, 2002

**Evaluation pattern**

At the end of the course, a two-hour test will be conducted for 50 marks. The marks will be converted to 100 for grading.

**Course Objectives**

- Understand basic concepts of eigen values and eigen vectors.
- Apply eigen values and eigen vectors for diagonalization and quadratic form.
- Apply various iterative techniques to solve the system of equations.

**Course Outcomes**

**CO1:** Understand the notion of eigenvalues and eigenvectors, analyse the possibility of diagonalization and hence compute a diagonal matrix, if possible.

**CO2:** Apply the knowledge of diagonalization to transform the given quadratic form into the principal axes form and analyse the given conic section.

**CO3:** Understand the advantages of the iterative techniques and apply it to solve the system of equations and finding eigenvectors.

**CO-PO Mapping**

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |
| CO1    | 3   | 2   | 1   |     |     |     |     |     |     |      |      |      |
| CO2    | 2   | 3   | 1   |     |     |     |     |     |     |      |      |      |
| CO3    | 3   |     | 1   |     |     |     |     |     |     |      |      |      |

**Syllabus****Unit 1**

Review: System of linear Equations, linear independence.

**Unit 2**

Eigen values and Eigen vectors: Definitions and properties. Positive definite, negative definite and indefinite

**Unit 3**

Diagonalization and Orthogonal Diagonalization. Properties of Matrices. Symmetric and Skew Symmetric Matrices, Hermitian and Skew Hermitian Matrices and Orthogonal matrices.

**Unit 4**

Numerical Computations: L U factorization, Gauss Seidal and Gauss Jacobi methods for solving system of equations. Power Method for Eigen Values and Eigen Vectors.

**Text Book**

*Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Tenth Edition, 2018.*

**Reference Books**

*Advanced Engineering Mathematics by Dennis G. Zill and Michael R.Cullen, second edition, CBS Publishers, 2012.*

*Engineering Mathematics', Srimanta Pal and Subhodh C Bhunia, John Wiley and Sons, 2012, Ninth Edition.*

**Evaluation Pattern**

| Assessment                     | Weightage |
|--------------------------------|-----------|
| Class Test/Assignment/Tutorial | 30        |
| End of course Test (2hrs)      | 70        |



**Course Objectives**

- This course provides the foundations of computational problem solving.
- The course focuses on principles and methods thereby providing transferable skills to any other domain.
- The course also provides foundation for developing computational perspectives of one's own discipline.

**Course Outcomes**

**CO 1:** Apply algorithmic thinking to understand, define and solve problems

**CO 2:** Design and implement algorithm(s) for a given problem

**CO 3:** Apply the basic programming constructs for problem solving

**CO 4:** Understand an algorithm by tracing its computational states, identifying bugs and correcting them

**CO-PO Mapping**

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 1   | 1   |     |     |     |     |     |     |     |      |      |      |      |      |
| CO2    | 3   | 2   | 3   |     | 3   |     |     | 3   | 3   | 3    |      |      |      |      |
| CO3    | 2   | 1   |     |     |     |     |     |     |     |      |      |      |      |      |
| CO4    | 1   | 1   | 2   |     | 2   |     |     |     |     |      |      |      |      |      |

**Syllabus****Unit 1**

Problem Solving and Algorithmic Thinking Overview – problem definition, logical reasoning; Algorithm – definition, practical examples, properties, representation, algorithms vs programs.

**Unit 2**

Algorithmic thinking – Constituents of algorithms – Sequence, Selection and Repetition, input-output; Computation – expressions, logic; algorithms vs programs, Problem Understanding and Analysis – problem definition, input-output, variables, name binding, data organization: lists, arrays etc. algorithms to programs.

**Unit 3**

Problem solving with algorithms – Searching and Sorting, Evaluating algorithms, modularization, recursion. C for problem solving – Introduction, structure of C programs, data types, data input, output statements, control structures.

**Text Book(s)**

Riley DD, Hunt KA. *Computational Thinking for the Modern Problem Solver*. CRC press; 2014 Mar 27.

**Reference(s)**

Ferragina P, Luccio F. *Computational Thinking: First Algorithms, Then Code*. Springer; 2018.

Beecher K. *Computational Thinking: A beginner's guide to Problem-solving and Programming*. BCS Learning & Development Limited; 2017.

Curzon P, McOwan PW. *The Power of Computational Thinking: Games, Magic and Puzzles to help you become a computational thinker*. World Scientific Publishing Company; 2017.

### Evaluation Pattern

| Assessment                            | Internal | End Semester |
|---------------------------------------|----------|--------------|
| Periodical 1                          | 10       |              |
| Periodical 2                          | 10       |              |
| *Continuous Assessment (Theory) (CAT) | 15       |              |
| Continuous Assessment (Lab) (CAL)     | 30       |              |
| End Semester                          |          | 35           |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.

**Course Objectives**

- To introduce the structure and physics of materials used in electronics
- To introduce the properties that characterize a material as a conductor, semiconductor or dielectric
- To analyze the electrical, magnetic and optical behavior of materials

**Course Outcomes**

**CO1:** Ability to understand the structure and physics of materials used in electronics.

**CO2:** Ability to understand the different parameters and terminology used in describing electronic properties of materials.

**CO3:** Ability to understand different properties of materials that result in specific electrical, optical and magnetic behavior.

**CO4:** Ability to understand and analyze the behavior of active and passive devices built from electronic materials.

**CO-PO Mapping:**

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |
| CO1    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    |
| CO2    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    |
| CO3    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    |
| CO4    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    |

**Keywords:** Electronic Properties of Materials, Semiconductor Physics, Electronic and Optoelectronic Devices

**Contents:****Module I: Crystal Structure of Solids**

Crystal directions and planes, crystal properties, defects and vacancies, two phase solids.

**Module II: Elementary Quantum Physics, Conductors**

Wave particle duality, uncertainty principle, potential well, tunnelling, potential box. Simulated emission and lasers. Conductors: Drude model, temperature dependence of resistivity, skin effect, AC conductivity, metal films, thin metal films, interconnects in microelectronics, electromigration.

**Module III: Semiconductors, Dielectrics**

Classification of semiconductors, doping, temperature dependence, minority carriers and recombination, diffusion and conduction equations, continuity equation, optical absorption, piezoresistivity. Dielectric materials: Polarization, polarization mechanisms, dielectric breakdown in solids, capacitors and their construction, piezoelectricity, ohmic and non ohmic contacts.

**Module IV: Magnetic Properties of Materials, Superconductors**

Dipole moment, permeability, classification of magnetic materials, saturation and Curie temperature, superconductivity.

**Module V: Optical Properties**

Light propagation in a homogeneous medium, absorption, scattering, luminescence, phosphors, LEDs, polarization, LCDs, electro optic effects.

**TEXTBOOKS/REFERENCES:**

1. *S O Kasap, "Principles of Electronic Materials and Devices", 4<sup>th</sup> Edition, McGraw Hill Education, 2018.*
2. *LSolymar, D Walsh and R R A Syms, "Electrical Properties of Materials", 9<sup>th</sup> Edition, Oxford University Press, 2014.*
3. *Rolf. E Hummel, "Electronic Properties of Materials", 4<sup>th</sup> Edition, Springer, 2012.*
4. *Eugene A Irene, Electronic Material Science, Wiley-Blackwell, 2005.*

**Evaluation Pattern 50:50**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

**Course Objectives**

- Familiarize with Bureau of Indian Standards (BIS) for creating engineering drawings
- Train the students on proper dimensioning and construction of simple geometries
- Inculcate with the concept of developing orthographic projections and isometric views using CAD drafting package

**Note:**

1. Drawing practice to be carried out using drafting package (Auto-CAD)
2. First angle projection to be followed

**Course Outcomes**

**CO1:** Understand the engineering drawing standards and their usage

**CO2:** Interpret engineering drawings

**CO3:** Construct and dimension 2-D geometries using CAD software

**CO4:** Improve coherent visualization skills

**CO5:** Inculcate with the concept of developing orthographic projections and isometric views

**CO-PO Mapping**

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |      |
| CO1    | 3   | 3   | 3   | 3   | 1   | 2   | 3   | 1   | 2   | 3    |      | 3    | 2    | 2    | 2    |
| CO2    | 3   | 3   | 3   | 3   |     | 2   | 3   | 1   | 2   | 3    |      | 3    | 2    | 2    | 2    |
| CO3    | 3   | 3   | 3   | 3   | 3   | 2   | 3   | 1   | 2   | 3    |      | 3    | 2    | 2    | 2    |
| CO4    | 3   | 3   | 3   | 3   |     | 2   | 3   | 1   | 2   | 3    |      | 3    | 2    | 2    | 2    |
| CO5    | 3   | 3   | 3   | 3   | 3   | 2   | 3   | 1   | 2   | 3    |      | 3    | 2    | 2    | 2    |

**Syllabus****Unit 1**

Basic principles of engineering drawing, Standards and conventions, lettering and types of lines, Introduction to drafting software, standard tool bar/menus, navigational tools. Co-ordinate system and reference planes. Creation of 2 dimensional drawing environment. Selection of drawing size and scale. Sketching of 2D simple geometries, editing and dimensioning of 2D geometries.

**Unit 2**

Orthographic Projections: Introduction, planes of projection, projection of points in all the four quadrants. Projection of straight lines, Projection of Plane Surfaces, Projection of regular solids, Sectioning of solids

**Unit 3**

Plan and elevation of simple buildings with dimensions

**Text Book**

*Basant Agarwal and C M Agarwal., “Engineering Drawing”, 2e, McGraw Hill Education, 2015*

**Reference Book(s)**

*Bhat N.D. and Panchal V.M. , “ Engineering Drawing Plane and Solid Geometry , 42e, Charoatar Publishing House , 2010*

*James D. Bethune, “Engineering Graphics with AutoCAD”, Pearson Education, 2014*

*K.R. Gopalakrishna, “Engineering Drawing”, 2014, Subhas Publications*

*Narayan K.L. and Kannaiah P, Engineering Drawing, SciTech Publications, 2003*

*John K.C., “Engineering Graphics for Degree”, 1e, Prentice Hall India, 2009*

**Evaluation Pattern**

| Assessment                  | Internal | End Semester |
|-----------------------------|----------|--------------|
| *Continuous Assessment (CA) | 80       |              |
| End Semester                |          | 20           |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.

### Course Objectives

- To impart basic knowledge of electrical quantities and provide working knowledge for the analysis of DC and AC circuits.
- To understand the construction and working principle of DC and AC machines.
- To facilitate understanding of basic electronics and operational amplifier circuits.

### Course Outcomes

**CO1:** Understand the basic electric and magnetic circuits

**CO2:** Analyse DC and AC circuits

**CO3:** Interpret the construction and working of different types of electrical machines

**CO4:** Analyse basic electronic components and circuits.

### CO-PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO2    | 3   | 3   | -   | 1   |     | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO3    | 3   | 3   | -   | -   |     | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO4    | 3   | 3   | 3   | 2   | -   | 1   | -   | -   | -   | -    | -    | -    | -    | -    |

### Syllabus

#### Unit 1

Introduction to Electrical Engineering, Current and Voltage sources, Resistance, Inductance and Capacitance; Ohm's law, Kirchhoff's law, Energy and Power – Series parallel combination of R, L, C components, Voltage Divider and Current Divider Rules – Super position Theorem, Network Analysis – Mesh and Node methods-Faraday's Laws of Electro-magnetic Induction, Magnetic Circuits, Self and Mutual Inductance, Generation of sinusoidal voltage, Instantaneous, Average and effective values of periodic functions, Phasor representation. Introduction to 3-phase systems, Introduction to electric grids.

#### Unit 2

Electrical Machines: DC Motor: Construction, principle of operation, Different types of DC motors, Voltage equation of a motor, significance of back emf, Speed, Torque, Torque-Speed characteristics, Output Power, Efficiency and applications. Single Phase Transformer: Construction, principle of operation, EMF Equation. Regulation and Efficiency of a Transformer. Induction Machine: Three Phase Induction Motor: Construction and Principle of Operation, Slip and Torque, Speed Characteristics. Stepper motor: Construction, principle and mode of operation.

#### Unit 3

PN Junction diodes, VI Characteristics, Rectifiers: Half wave, Full wave, Bridge. Zener Diode- characteristics, Optoelectronic devices. BJT – characteristics and configurations, Transistor as a Switch. Junction Field Effect Transistors - operation and characteristics, Thyristor – Operation and characteristics. Fundamentals of DIAC and

TRIAC. 555 Timer, Integrated circuits. Operational Amplifiers – Inverting and Non-inverting amplifier – Instrumentation amplifiers.

### Text Books

*Edward Hughes. "Electrical and Electronic Technology", 10<sup>th</sup> Edition, Pearson Education Asia, 2019.*

*D. P. Kothari, I J Nagrath, "Electric Machines", 5<sup>th</sup> Edition, Tata McGraw Hill, 2017.*

*A. P. Malvino, "Electronic Principles", 7<sup>th</sup> Edition, Tata McGraw Hill, 2007.*

### References

*S. K. Bhattacharya, "Basic Electrical and Electronics Engineering", Pearson, 2012.*

*Vincent Del Toro, "Electrical Engineering Fundamentals", Prentice Hall of India Private Limited, 2<sup>nd</sup> Edition, 2003.*

*David A. Bell, "Electronic Devices and Circuits", 5<sup>th</sup> Edition, Oxford University Press, 2008.*

*Michael Tooley B. A., "Electronic circuits: Fundamentals and Applications", 3<sup>rd</sup> Edition, Elsevier Limited, 2006.*

### Evaluation Pattern

| Assessment                  | Internal | End Semester |
|-----------------------------|----------|--------------|
| Periodical 1 (P1)           | 15       |              |
| Periodical 2 (P2)           | 15       |              |
| *Continuous Assessment (CA) | 20       |              |
| End Semester                |          | 50           |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.



**Course Objective**

- To understand the basics of electrical connections and analyse the performance of electrical machines and electronic circuits.

**Course Outcome**

**CO1:** To create basic electrical connections for domestic applications

**CO2:** To measure the various electrical parameters in the circuit

**CO3:** To Analyse the performance of electrical machines.

**CO4:** To Analyse basic electronic circuits.

**CO-PO Mapping**

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   |     | 2   |     |     | 2   |     |     | 3   |      |      | 1    |      |      |
| CO2    | 3   |     |     |     | 2   |     |     |     | 3   |      |      | 1    |      |      |
| CO3    | 3   | 1   | 2   | 2   |     |     |     |     | 3   |      |      | 1    |      |      |
| CO4    | 3   | 1   | 2   |     |     |     |     |     | 3   |      |      |      |      |      |

**LIST OF EXPERIMENTS:**

Electrical

- a) Wiring practices  
b) Study of Electrical protection systems.
- Verification of circuit theorem
- Experiment on DC machine
- Experiment on single phase Transformer
- Experiment on induction motor
- VI characteristics of PN junction and Zener diode
- Implementation of Half wave and Full wave rectifier using PN junction diode
- Transistor as a switch
- Experiment on Thyristor
- Implementation of inverting and non-inverting amplifier using Op-amp

**REFERENCES / MANUALS / SOFTWARE:**

Lab Manuals

**Evaluation Pattern**

| Assessment                  | Internal | End Semester |
|-----------------------------|----------|--------------|
| *Continuous Assessment (CA) | 80       |              |
| End Semester                |          | 20           |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.

**Pre Requisite(s):** Nil

### Course Objectives

- To develop basic Programming Skills through Graphical Programming
- To learn Hardware Interfacing and Debugging Techniques
- To design and develop Android App for Smart Home Automation

### Course Outcomes

**CO1:** Able to demonstrate various sensor interfacing using Visual Programming Language

**CO2:** Able to analyze various Physical Computing Techniques

**CO3:** Able to demonstrate Wireless Control of Remote Devices

**CO4:** Able to design and develop Mobile Application which can interact with Sensors and Actuators

### CO – PO Mapping

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1   | 3   | -   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO2   | 3   | 2   | 3   | -   | 2   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO3   | 3   | -   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO4   | 3   | 3   | 3   | 3   | 2   | 2   | 2   | 2   | 3   | 3    | -    | -    | 3    | 2    |

### Syllabus

1. Digital I/O Interface - Multicolour Led, IR Sensor, PIR, SlotSensor.
2. Analog Read and Write - Potentiometer, Temperature Sensor, Led Brightness Control.
3. Dc Motor Control - Dc Motor Speed and Direction Control.
4. Fabrication and direction control of wheeled robot using Arduino.
5. Serial Communication - Device Control.
6. Wireless Module Interface - Bluetooth and Wifi.
7. Wireless Control of wheeled Robot using Bluetooth/Wifi.
8. Basic Android App Development using MIT App Inventor.
9. Smart Home Android App Development using App Inventor and Arduino.
10. Assembly of Quadcopter/Tello Mini Drone.
11. Programming and Flight Control of Quadcopter.

### Text book(s)/Reference(s)

*Sylvia Libow Martinez, Gary S Stager, "Invent To Learn: Making, Tinkering, and Engineering in the Classroom", Constructing Modern Knowledge Press, 2016.*

*Michael Margolis, "Arduino Cookbook", Oreilly, 2011.*

### Evaluation Pattern

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| *Continuous Assessment (CA) | 80       |          |
| End Semester                |          | 20       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.

**Course Objective**

- The course is designed as an introductory guide to the variegated dimensions of Indian cultural and intellectual heritage, to enable students to obtain a synoptic view of the grandiose achievements of India in diverse fields.
- It will equip students with concrete knowledge of their country and the mind of its people and instil in them some of the great values of Indian culture.

**Course Outcomes**

**CO1:** Be introduced to the cultural ethos of Amrita Vishwa Vidyapeetham, and Amma's life and vision of holistic education.

**CO2:** Understand the foundational concepts of Indian civilization like *puruśārtha*-s, law of karma and *varṇāśrama*.

**CO3:** Gain a positive appreciation of Indian culture, traditions, customs and practices.

**CO4:** Imbibe spirit of living in harmony with nature, and principles and practices of Yoga.

**CO5:** Get guidelines for healthy and happy living from the great spiritual masters

**CO-PO Mapping**

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    |     |     |     |     |     | 3   | 2   | 3   |     |      |      | 2    |      |      |
| CO2    |     |     |     |     |     | 3   | 1   | 3   |     |      |      | 2    |      |      |
| CO3    |     |     |     |     |     | 3   | 1   | 3   |     |      |      | 2    |      |      |
| CO4    |     |     |     |     |     | 3   | 3   | 3   |     |      |      | 2    |      |      |
| CO5    |     |     |     |     |     | 3   | 1   | 3   |     |      |      | 2    |      |      |

**Syllabus****Unit 1**

Introduction to Indian culture; Understanding the cultural ethos of Amrita Vishwa Vidyapeetham; Amma's life and vision of holistic education.

**Unit 2**

Goals of Life – Purusharthas; Introduction to Varnasrama Dharma; Law of Karma; Practices for Happiness.

**Unit 3**

Symbols of Indian Culture; Festivals of India; Living in Harmony with Nature; Relevance of Epics in Modern Era; Lessons from Ramayana; Life and Work of Great Seers of India.

**Text Book**

*Cultural Education Resource Material Semester-1*

**Reference Book(s)**

*The Eternal Truth (A compilation of Amma's teachings on Indian Culture)*

*Eternal Values for a Changing Society. Swami Ranganathananda. Bharatiya Vidya Bhavan.*

*Awaken Children (Dialogues with Mata Amritanandamayi) Volumes 1 to 9*

*My India, India Eternal. Swami Vivekananda. Ramakrishna Mission.*

**Evaluation Pattern:**

| Assessment                  | Internal | End Semester |
|-----------------------------|----------|--------------|
| Periodical 1 (P1)           | 15       |              |
| Periodical 2 (P2)           | 15       |              |
| *Continuous Assessment (CA) | 20       |              |
| End Semester                |          | 50           |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.

## SEMESTER II

19ENG111

TECHNICAL COMMUNICATION

L-T-P-C: 2-0-3-3

### Course Objectives

- To introduce the students to the elements of technical style
- To introduce the basic elements of formal correspondence
- To introduce technical paper writing skills and methods of documentation
- To improve oral presentation skills in formal contexts

### Course Outcomes

**CO1:** Understand and use the basic elements of formal correspondence and methods of documentation.

**CO2:** Learn to edit technical content for grammatical accuracy and appropriate tone and style

**CO3:** Use the library and Internet resources for research purposes

**CO4:** Demonstrate the ability to communicate effectively through group mock-technical presentations and other activities

### CO-PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    |     |     |     |     |     |     |     |     |     | 3    |      |      |      |      |
| CO2    |     |     |     |     |     |     |     |     |     | 3    |      |      |      |      |
| CO3    |     |     |     | 1   |     |     |     |     |     |      |      |      |      |      |
| CO4    |     |     |     |     |     |     |     |     | 3   | 3    |      |      |      |      |

### Syllabus

#### Unit 1

Mechanics of Writing: Grammar rules -articles, tenses, auxiliary verbs (primary & modal) prepositions, subject-verb agreement, pronoun-antecedent agreement, discourse markers and sentence linkers

General Reading and Listening comprehension - rearrangement & organization of sentences

#### Unit 2

Different kinds of written documents: Definitions- descriptions- instructions-recommendations- user manuals - reports – proposals

Formal Correspondence: Writing formal Letters

Mechanics of Writing: impersonal passive & punctuation

Scientific Reading & Listening Comprehension

#### Unit 3

Technical paper writing: documentation style - document editing – proof reading - Organising and formatting

Mechanics of Writing: Modifiers, phrasal verbs, tone and style, graphical representation

Reading and listening comprehension of technical documents

Mini Technical project (10 -12 pages)

Technical presentations

## References

- Hirsh, Herbert. L. "Essential Communication Strategies for Scientists, Engineers and Technology Professionals". II Edition. New York: IEEE press, 2002
- Anderson, Paul. V. "Technical Communication: A Reader-Centred Approach". V Edition. Harcourt Brace College Publication, 2003
- Strunk, William Jr. and White. EB. "The Elements of Style" New York. Alliyen & Bacon, 1999.
- Riordan, G. Daniel and Pauley E. Steven. "Technical Report Writing Today" VIII Edition (Indian Adaptation). New Delhi: Biztantra, 2004.
- Michael Swan. "Practical English Usage", Oxford University Press, 2000

## Evaluation Pattern

| Assessment                        | Internal | External |
|-----------------------------------|----------|----------|
| Periodical 1                      | 20       |          |
| Periodical 2                      | 20       |          |
| Continuous Assessment (Lab) (CAL) | 40       |          |
| End Semester                      |          | 20       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.

**Course Objective**

- To understand parameterisation of curves and to find arc lengths.
- To familiarise with calculus of multiple variables.
- To use important theorems in vector calculus in practical problems.

**Course Outcomes**

**CO1:** Select suitable parameterization of curves and to find their arc lengths

**CO2:** Find partial derivatives of multivariable functions and to use the Jacobian in practical problems.

**CO3:** Apply Fundamental Theorem of Line Integrals, Green's Theorem, Stokes' Theorem, of Divergence Theorem to Evaluate integrals.

**CO-PO Mapping**

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |
| CO1    | 1   | 3   | --- | --- | --- | --- | --- | --- | --- | ---  | ---  | ---  |
| CO2    | 1   | 2   | --- | --- | 2   | --- | --- | --- | --- | ---  | ---  | ---  |
| CO3    | 2   | 2   |     |     | 3   |     |     |     |     |      |      |      |

**Syllabus****Unit 1**Functions of severable variables

Functions, limit and continuity. Partial differentiations, total derivatives, differentiation of implicit functions and transformation of coordinates by Jacobian. Taylor's series for two variables.

**Unit 2**Vector Differentiation

Vector and Scalar Functions, Derivatives, Curves, Tangents, Arc Length, Curves in Mechanics, Velocity and Acceleration, Gradient of a Scalar Field, Directional Derivative, Divergence of a Vector Field, Curl of a Vector Field.

**Unit 3**Vector Integration

Line Integral, Line Integrals Independent of Path.

Green's Theorem in the Plane, Surfaces for Surface Integrals, Surface Integrals, Triple Integrals – Gauss Divergence Theorem, Stoke's Theorem.

**Unit 4**Lab Practice Problems:

Graph of functions of two variables, shifting and scaling of graphs. Vector products. Visualizing different surfaces.

**Text Book**

*Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Tenth Edition, 2018.*

**Reference Book(s)**

*Advanced Engineering Mathematics by Dennis G. Zill and Michael R. Cullen, second edition, CBS Publishers, 2012.*

*'Engineering Mathematics', Srimanta Pal and Subhodh C Bhunia, John Wiley and Sons, 2012, Ninth Edition.*

*'Calculus', G.B. Thomas Pearson Education, 2009, Eleventh Edition.*

**Evaluation Pattern**

| Assessment                     | Weightage |
|--------------------------------|-----------|
| Class Test/Assignment/Tutorial | 30        |
| End of course Test (2hrs)      | 70        |



**Course Objectives**

- Understand the basic concepts of vector space, subspace, basis and dimension.
- Familiar the inner product space. Finding the orthogonal vectors using inner product.
- Understand and apply linear transform for various matrix decompositions.

**Course Outcomes**

**CO1:** Understand the basic concepts of vector space, subspace, basis and dimension.

**CO2:** Understand the basic concepts of inner product space, norm, angle, Orthogonality and projection and implementing the Gram-Schmidt process, to obtain least square solution.

**CO3:** Understand the concept of linear transformations, the relation between matrices and linear transformations, kernel, range and apply it to change the basis, to get the QR decomposition, and to transform the given matrix to diagonal/Jordan canonical form.

**CO4:** Understand the concept of positive definiteness, matrix norm and condition number for a given square matrix.

**CO-PO Mapping**

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO 12 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|-------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |       |
| CO1    | 3   | 2   | 1   |     |     |     |     |     |     |      |      |       |
| CO2    | 3   | 3   | 2   |     |     |     |     |     |     |      |      |       |
| CO3    | 3   | 3   | 2   |     |     |     |     |     |     |      |      |       |
| CO4    | 3   | 2   | 1   |     |     |     |     |     |     |      |      |       |

**Syllabus****Pre-request: Matrices**

Review of matrices and linear systems of equations. (2 hrs)

**Vector Spaces:** Vector spaces - Sub spaces - Linear independence - Basis - Dimension - Inner products - Orthogonality - Orthogonal basis - Gram Schmidt Process - Change of basis. (12 hrs)

Orthogonal complements - Projection on subspace - Least Square Principle. (6 hrs)

**Linear Transformations:** Positive definite matrices - Matrix norm and condition number - QR- Decomposition - Linear transformation - Relation between matrices and linear transformations - Kernel and range of a linear transformation. (10 hrs)

Change of basis - Nilpotent transformations - Similarity of linear transformations - Diagonalisation and its applications - Jordan form and rational canonical form. (10 hrs)

**SVD.**

**Text Book**

Howard Anton and Chris Rorrs, "Elementary Linear Algebra", Ninth Edition, John Wiley & Sons, 2000.

**Reference Book(s)**

D. Poole, *Linear Algebra: A Modern Introduction*, 2nd Edition, Brooks/Cole, 2005.

Gilbert Strang, "Linear Algebra and its Applications", Third Edition, Harcourt College Publishers, 1988.

### Evaluation Pattern

| Assessment                  | Internal | End Semester |
|-----------------------------|----------|--------------|
| Periodical 1 (P1)           | 15       |              |
| Periodical 2 (P2)           | 15       |              |
| *Continuous Assessment (CA) | 20       |              |
| End Semester                |          | 50           |

•CA – Can be Quizzes, Assignment, Projects, and Reports

**Course Objectives**

- The main objective of the course is to impart knowledge on the fundamental concepts of chemistry involved in application of several important engineering materials that are used in the industry/day-to-day life.

**Course Outcomes**

**CO1:** To understand the fundamental concepts of chemistry to predict the structure, properties and bonding of Engineering materials.

**CO2:** To understand the principle of electrochemistry/photochemistry and applications of various energy Storage system.

**CO3:** To be able to understand the crystals structure, defects and free electron theory

**CO4:** To be able to understand the mechanism and application of conductivity polymer in various electronic devices.

**CO-PO Mapping**

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |
| CO 1   | 3   | 3   | 2   | 2   |     |     |     |     |     |      |      | 2    |
| CO 2   | 3   | 3   | 2   | 2   |     |     |     |     |     |      |      | 2    |
| CO 3   | 3   | 3   | 3   | 3   |     |     |     |     |     |      |      | 2    |
| CO 4   | 3   | 3   | 2   | 3   |     |     |     |     |     |      |      | 2    |

**SYLLABUS****Unit 1****Atomic Structure and Chemical Bonding**

Fundamental particles of atom – their mass, charge and location – atomic number and mass number – Schrodinger equation. Significance of  $\psi$  and  $\psi^2$  – orbital concept – quantum numbers - electronic configuration. Periodic properties. Formation of cation and anion by electronic concept of oxidation and reduction – theories on bonding- octet, Sidwick and Powell, VSEPR and VBT-MOT. Formation of electrovalent, covalent and coordination compounds. Chemistry of weak interactions – van der Waals force and hydrogen bonding.

**Unit 2****Electrochemical energy system**

Faradays laws, origin of potential, electrochemical series, reference electrodes, Nernst equation, introduction to batteries – classification – primary, secondary and reserve (thermal) batteries. Characteristics – cell potential, current, capacity and storage density, energy efficiency. Construction, working and application of Leclanche cell- Duracell, Li-MnO<sub>2</sub> cell, lead acid batteries. Ni-Cd battery, Lithium ion batteries. Fuel cell - construction and working of PEMFC.

### Unit 3

#### Photochemistry and solar energy

Electromagnetic radiation. Photochemical and thermal reactions. Laws of photochemistry, quantum yield, high and low quantum yield reactions. Jablonski diagram - photophysical and photochemical processes, photosensitization, photo-polymerization and commercial application of photochemistry.

Solar energy - introduction, utilization and conversion, photovoltaic cells – design, construction and working, panels and arrays. Advantages and disadvantages of PV cells. DSSC (elementary treatment).

### Unit 4

#### Solid state Chemistry

Crystalline and amorphous solids, isotropy and anisotropy, elements of symmetry in crystal systems indices - Miller indices, space lattice and unit cell, Bravais lattices, the seven crystal systems and their Bravais lattices, X-ray diffraction - Bragg's equation and experimental methods (powder method and rotating crystal technique), types of crystals - molecular, covalent, metallic and ionic crystals - close packing of spheres – hexagonal, cubic and body centred cubic packing, defects in crystals – stoichiometric, non-stoichiometric, extrinsic and intrinsic defects.

### Unit 5

#### Polymer and composite Materials

Conducting polymers: Conducting mechanisms - Electron transport and bipolar polymers. Photoconductive polymers: Charge carriers, charge injectors, charge transport, charge trapping. Polymers for optical data storage - principles of optical storage, polymers in recording layer. Thermo sensitive polymers: Applications - Mechanical actuators and switches. Photo resists - Types - Chemically amplified photoresists -Applications. Magnetic polymers - structure and Applications. Liquid crystalline polymers: Fundamentals and process, liquid crystalline displays – applications. Organic LEDs-their functioning-advantages and disadvantages over conventional LEDs - their commercial uses. Piezo electric materials.

#### Text Books

Vairam and Ramesh “Engineering Chemistry”, Wiley, 2012 Amrita Vishwa Vidyapeetham, Department of Sciences, “Chemistry Fundamentals for Engineers”, McGraw Hill Education, 2015.

#### Reference Books

Jain and Jain, “Engineering Chemistry”, DhanpatRai Publishing company, 2015

Puri, Sharma and Patania, “ Principles of Physical chemistry”, Vishal Publishing Co., 2017.

Atkins, “Physical Chemistry”, OUP, Oxford, 2009

#### Evaluation Pattern

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Course Objective**

- The objective of the laboratory sessions is to enable the learners to get hands-on experience on the principles discussed in theory sessions and to understand the applications of these concepts in engineering.

**Course Outcomes**

**CO1:** Learn and apply basic techniques used in chemistry laboratory for small/large scale water Analyses / Purification.

**CO2:** be able estimate the ions/metal ions present in domestic/industry waste water.

**CO3:** utilize the fundamental laboratory techniques for analyses such as titrations, separation/purification and Spectroscopy.

**CO4:** able to analyze and gain experimental skill.

**CO-PO Mapping**

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |
| CO 1   | 3   | 3   | 3   | 2   |     |     |     |     |     |      |      | 2    |
| CO 2   | 3   | 3   | 2   | 2   |     |     |     |     |     |      |      | 2    |
| CO 3   | 3   | 3   | 3   | 3   |     |     |     |     |     |      |      | 2    |
| CO 4   | 3   | 3   | 3   | 3   |     |     |     |     |     |      |      | 2    |

**Lab:**

1. Estimation of alkalinity in given water samples
2. Adsorption of acetic acid by charcoal
3. Potentiometric titration – acid-base/redox
4. Conductometric titration
5. Estimation of hardness by ion-exchange method
6. Determination of molecular weight of polymer
7. Determination of cell constant and unknown concentration of electrolyte
8. Estimation of tin from stannate solution
9. Separation techniques – TLC, Column chromatography
10. Verification of B-L law by UV-spectrophotometer

**Evaluation Pattern**

| Assessment                  | Internal | End Semester |
|-----------------------------|----------|--------------|
| *Continuous Assessment (CA) | 80       |              |
| End Semester                |          | 20           |

\* CA – Principles of experiment, skill, result analysis and report

**Pre-Requisite(s):** 19CSE100 Problem Solving and Algorithmic Thinking

### Course Objectives

- This course provides the foundations of programming.
- Apart from the usual mechanics of a typical programming language, the principles and methods will form the main focus of this course.
- Shift from learn to program to programming to learn forms the core of this course.

### Course Outcome

**CO1:** Understand the typical programming constructs: data (primitive and compound), control, modularity, recursion etc. thereby to understand a given program

**CO2:** Understand and analyze a given program by tracing, identify coding errors and debug them

**CO3:** Make use of the programming constructs appropriately and effectively while developing computer programs

**CO4:** Develop computer programs that implement suitable algorithms for problem scenarios and applications

### CO-PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 1   |     |     |     |     |     |     | 1   |     |      |      |      |      |      |
| CO2    | 1   | 1   | 1   |     |     |     |     | 1   |     |      |      |      |      |      |
| CO3    | 1   | 2   | 2   |     |     |     |     | 2   |     |      |      |      |      |      |
| CO4    | 2   | 3   | 2   |     |     |     |     | 3   |     |      |      |      |      |      |

### Syllabus

#### Unit 1

Introduction and Review of C language constructs. Functions – inter function communication, standard functions, scope. Recursion – recursive definition, recursive solution, designing recursive functions, limitations of recursion. Arrays – 1D numeric, searching and sorting, 2D numeric arrays.

#### Unit 2

Pointers: introduction, compatibility, arrays and pointers, Dynamic memory allocation, arrays of pointers, pointer arithmetic. Strings: fixed length and variable length strings, strings and characters, string input, output, array of strings, string manipulation functions, sorting of strings.

#### Unit 3

Structures: structure vs array comparison, complex structures, structures and functions, Union. Files and streams, file input output, command line arguments.

#### Text Book(s)

Forouzan BA, Gilberg RF. *Computer Science: A structured programming approach using C. Third Edition, Cengage Learning; 2006.*

#### Reference(s)

Byron Gottfried. *Programming With C. Fourth Edition, McGrawHill,; 2018.*

Brian W. Kernighan and Dennis M. Ritchie. *The C Programming Language. Second Edition, Prentice Hall, 1988.*

*Eric S. Roberts. Art and Science of C. Addison Wesley; 1995.*

*Jeri Hanly and Elliot Koffman. Problem Solving and Program Design in C. Fifth Edition, Addison Wesley (Pearson); 2007.*

### **Evaluation Pattern**

| Assessment                            | Internal | End Semester |
|---------------------------------------|----------|--------------|
| Periodical 1                          | 10       |              |
| Periodical 2                          | 10       |              |
| *Continuous Assessment (Theory) (CAT) | 15       |              |
| Continuous Assessment (Lab) (CAL)     | 30       |              |
| End Semester                          |          | 35           |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.

**Pre Requisite(s):** Nil

### Course Objectives

- To understand the fundamentals of Boolean Logic and the building blocks of digital circuits
- To introduce the abstraction of simple practical problems into Boolean Logic and their efficient implementation
- To introduce the fundamentals of design with combinational and sequential subsystems

### Course Outcomes

**CO1:** Able to frame Boolean equations for solving a simple real-life engineering problem and realize them using gate- level building blocks

**CO2:** Able to apply minimization techniques for efficient Boolean logic implementation

**CO3:** Able to realize digital blocks using combinational and sequential subsystems

**CO4:** Able to design using state machine descriptions for practical real-life engineering problems

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |
| CO2    | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |
| CO3    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |
| CO4    | 3   | 3   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |

### Syllabus

#### Unit 1

Introduction to logic circuits - Variables and functions - inversion - Truth tables - Logic gates and Networks – Boolean algebra - Synthesis using gates - Design examples - Optimized implementation of logic functions - Karnaugh map – Strategy for minimization - Minimization of product of sums forms - Incompletely specified functions - Multiple output circuits - Tabular method for minimization - Number representation and arithmetic circuits - Addition of unsigned numbers - Signed numbers - Fast adders.

#### Unit 2

Combinational circuit building blocks- Multiplexers - Decoders - Encoders - Code converters - Arithmetic comparison circuits- Sequential circuit building blocks - Basic latch - Gated SR latch - Gated D latch - Master slave and edge triggered - D flip-flops - T flip-flop - JK flip-flop - Registers - Counters - Reset synchronization - Other types of counters.

#### Unit 3

Synchronous sequential circuits - Basic design steps - State assignment problem - Mealy state model - Serial Adders– State minimization -Introduction to Asynchronous sequential circuits – Introduction to CMOS logic.



**Text book(s)**

Stephen Brown, Zvonko Vranesic, "Fundamentals of Digital logic with Verilog Design", Tata McGraw Hill Publishing Company Limited, Special Indian Edition, 2007.

M Morris Mano and Michael D Ciletti, "Digital Design with Introduction to the Verilog HDL", Pearson Education, Fifth Edition, Fifth Edition, 2015.

**Reference(s)**

John F. Wakerly, "Digital Design Principles and Practices", Fourth Edition, Pearson Education, 3rd Ed, 2008.

Donald D Givone, "Digital Principles and Design", Tata McGraw Hill Publishing Company Limited, 2003.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.

**Pre Requisite(s):** Nil

### Course Objectives

- Familiarization of digital components and ICs used as building blocks for realizing larger systems
- To learn to realize and troubleshoot simple digital circuits using logic gate ICs on the breadboard and verify their truth tables
- To learn to use off-the-shelf subsystems such as MSI ICs such as adders, decoders and multiplexers by appropriately configuring them with the help of datasheets for realizing circuits to solve a practical engineering problem

### Course Outcomes

**CO1:** Able to identify, configure and use off-the-shelf digital ICs

**CO2:** Able to realize and troubleshoot combinational and sequential digital circuits

**CO3:** Able to employ MSI ICs of appropriate configuration for realizing a digital system

**CO4:** Able to design and implement simple digital system for a real-life problem

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |
| CO2    | 3   | 2   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |
| CO3    | 3   | 2   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |
| CO4    | 3   | 2   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |

### Syllabus

- Study of Logic Gate ICs.
- Realization of Boolean functions using logic gate ICs.
- Truth table based design and implementation of simple real life problems.
- Implementation of digital systems using MSI building blocks such as adders, multiplexers and decoders.
- Breadboard realization of synchronous sequential circuits.
- Digital system design and implementation for a real-life problem.

### Text book(s)

1. *Stephen Brown, Zvonko Vranesic, "Fundamentals of Digital logic with Verilog Design", Tata McGraw Hill Publishing Company Limited, Special Indian Edition, 2007.*
2. *M Morris Mano and Michael D Ciletti, "Digital Design with Introduction to the Verilog HDL", Pearson Education, Fifth Edition, 2015.*

### Reference(s)

1. *John F. Wakerly, "Digital Design Principles and Practices", Pearson Education, Fourth Edition, 2008.*
2. *K A Navas, "Electronic Lab Manual – Volume 1", Fifth Edition, Prentice Hall of India, 2015.*

### Evaluation Pattern

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| *Continuous Assessment (CA) | 80       |          |
| End Semester                |          | 20       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.

**Course Objectives**

- Introduce basic concepts pertaining to product dismantling and assembly.
- Familiarize with basic pneumatic components and design & validate simple pneumatic circuits.
- Familiarize with sheet metal tools and operations.
- Provide hands-on training on welding and soldering.
- Familiarize with plumbing tools and processes.
- Inculcate and apply the principles of 3D printing to build simple geometries.

**Course Outcomes**

**CO1:** Interpret the functionality of various components in a product through dismantling and assembly

**CO2:** Identify various pneumatic and electro-pneumatic components

**CO3:** Fabricate simple sheet metal objects using concepts of surface development

**CO4:** Perform metal joining operations using soldering and arc welding

**CO5:** Make simple plumbing joints for domestic applications

**CO6:** Build simple geometries using 3D printing tools

**CO-PO MAPPING**

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |      |
| CO1    | 2   | 1   |     |     |     |     |     |     | 2   | 1    |      | 1    | 1    |      |      |
| CO2    | 2   | 2   | 1   |     | 1   |     |     |     | 2   | 1    |      | 1    | 1    | 1    |      |
| CO3    | 2   | 2   |     |     |     |     |     |     | 2   | 1    |      | 1    | 1    |      |      |
| CO4    | 2   | 1   |     |     |     |     |     |     | 2   | 1    |      | 1    | 1    |      |      |
| CO5    | 2   |     | 2   |     | 2   |     |     |     |     |      |      | 1    | 1    | 1    |      |
| CO6    | 2   | 2   | 1   |     | 1   |     |     |     | 2   | 1    |      | 1    | 1    | 1    |      |

**Syllabus****Product Workshop**

Disassemble the product of sub assembly-Measure various dimensions using measuring instruments-Free hand rough sketch of the assembly and components-Name of the components and indicate the various materials used-Study the functioning of the assembly and parts-Study the assembly and components design for compactness, processing, ease of assembly and disassembly-Assemble the product or subassembly.

**Pneumatic and PLC Workshop**

Study of pneumatic elements-Study of PLC and programming. Design and simulation of simple circuits using basic pneumatic elements-Design and simulation of simple circuits using electro-pneumatics.

### **Sheet Metal Workshop**

Study of tools and equipment - Draw development drawing of simple objects on sheet metal (cone, cylinder, pyramid, prism, tray etc.)-Fabrication of components using small shearing and bending machines-Riveting practice.

### **Welding, Soldering and Plumbing Workshops**

Study of tools and equipment - Study of various welding & soldering methods

Arc welding practice - fitting, square butt joint and lap joint - Soldering practice. Plumbing tools – Make a piping joint to a simple piping layout (should include cutting, threading and pipe fixing)

### **3D-Printing Workshop**

#### **Evaluation Pattern**

| Assessment                  | Internal | End Semester |
|-----------------------------|----------|--------------|
| *Continuous Assessment (CA) | 80       |              |
| End Semester                |          | 20           |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.

**Pre Requisite(s):** Nil

### Course Objectives

- To implement Hardware Prototype for a specific application
- To develop basic Graphical User Interface suitable for data visualization
- To design and develop microcontroller based solution for automating a particular process

### Course Outcomes

**CO1:** Able to demonstrate both analog and digital sensor interfacing with a programmable platform

**CO2:** Able to implement various communication protocols used in the design of portable devices

**CO3:** Able to develop graphical control panel using processing IDE

**CO4:** Able to design and develop embedded systems using Arduino and Processing IDE

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | -   | 2   | -   | -   | -   | -   | -   | 2   | 2    | -    | -    | -    | -    |
| CO2    | 3   | 2   | 3   | -   | 2   | -   | -   | -   | 3   | 3    | -    | -    | -    | -    |
| CO3    | 3   | -   | 3   | -   | -   | -   | -   | -   | 3   | 3    | -    | -    | -    | -    |
| CO4    | 3   | 3   | 3   | 3   | 2   | 2   | 2   | 2   | 3   | 3    | -    | -    | 3    | 2    |

### Syllabus

1. GPIO and ADC Interfacing - LED, Switch, Relay, Proximity Sensor, Temperature Sensor, Moisture Sensor.
2. Serial Communication – Bluetooth, ZigBee, RFID.
3. GSM and GPS Interfacing.
4. Motor Interfacing – DC, Stepper, Servo.
5. I2C Interface – EEPROM, RTC.
6. Internet of Things – Wifi Web Server, MQTT.
7. Cloud Interfacing – UbiDots, Thinkspeak.
8. Processing IDE – 2D, 3D operations, Colour Transformations.
9. Image and Video Processing – Thresholding, Pixel manipulation, Filters, Colour Tracking.
10. Keyboard and Mouse Interfacing –Arduino Interface.

### Text book(s)

Michael Margolis, “Arduino Cookbook”, Oreilly, 2011.

Casey Reas, Ben Fry, “Processing: A Programming Handbook for Visual Designers and Artists”, The MIT Press, 2014.

**Reference(s)**

Jan Vantomme, “Processing 2: Creative Programming Cookbook”, Packt Publishing, 2012.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| *Continuous Assessment (CA) | 80       |          |
| End Semester                |          | 20       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.

**Course Objective**

- To deepen students' understanding and further their knowledge about the different aspects of Indian culture and heritage.
- To in still into students a dynamic awareness and understanding of their country's achievements and civilizing influences in various fields and at various epochs.

**Course Outcome**

**CO1:** Get an overview of Indian contribution to the world in the field of science and literature.

**CO2:** Understand the foundational concepts of ancient Indian education system.

**CO3:** Learn the important concepts of Vedas and *Yogasutra*-s and their relevance to daily life.

**CO4:** Familiarize themselves with the inspirational characters and anecdotes from the *Mahābhārata* and *Bhagavad-Gītā* and Indian history.

**CO5:** Gain an understanding of Amma's role in the empowerment of women

**CO-PO Mapping**

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    |     |     |     |     |     | 3   | 3   |     |     |      |      | 2    |      |      |
| CO2    |     |     |     |     |     | 1   |     | 3   |     |      |      | 2    |      |      |
| CO3    |     |     |     |     |     | 3   | 3   | 3   |     |      |      | 2    |      |      |
| CO4    |     |     |     |     |     | 3   | 3   | 3   |     |      |      | 2    |      |      |
| CO5    |     |     |     |     |     | 1   |     | 1   |     |      |      |      |      |      |

**Syllabus****Unit 1**

To the World from India; Education System in India; Insights from Mahabharata; Human Personality. India's Scientific System for Personality Refinement.

**Unit 2**

The Vedas: An Overview; One God, Many Forms; Bhagavad Gita – The Handbook for Human Life; Examples of Karma Yoga in Modern India.

**Unit 3**

Chanakya's Guidelines for Successful Life; Role of Women; Conservations with Amma.

**Text Book**

Cultural Education Resource Material Semester-2

**Reference Book(s)**

*Cultural Heritage of India. R.C.Majumdar. Ramakrishna Mission Institute of Culture.*  
*The Vedas. Swami ChandrashekharaBharati. BharatiyaVidyaBhavan.*  
*Indian Culture and India's Future. Michel Danino. DK Publications.*  
*The Beautiful Tree. Dharmapal. DK Publications.*  
*India's Rebirth. Sri Aurobindo. Auroville Publications.*

**Evaluation Pattern:**

| Assessment                  | Internal | End Semester |
|-----------------------------|----------|--------------|
| Periodical 1 (P1)           | 15       |              |
| Periodical 2 (P2)           | 15       |              |
| *Continuous Assessment (CA) | 20       |              |
| End Semester                |          | 50           |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.



## SEMESTER III

**19CCE201      MICROCONTROLLERS AND INTERFACING TECHNIQUES      L-T-P-C: 3-0-3-4**

**Pre Requisite(s):** Digital Design

### Course Objectives

- To introduce the advanced features of an advanced RISC Microprocessor
- To apply the knowledge of Embedded C Programming for configuring various peripherals of a microcontroller
- To Design and Develop Microcontroller based solution for solving real world problems

### Course Outcomes

**CO1:** Able to identify the importance of 32 bit Microprocessor

**CO2:** Able to understand architecture of the ARM Processor

**CO3:** Able to analyze Peripherals and their programming aspects

**CO4:** Able to design and develop embedded systems using microcontroller

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | -   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO2    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    |      |
| CO3    | 3   | 3   | 3   | -   | -   | -   | -   | -   | 3   | 3    | -    | -    | 2    | -    |
| CO4    | 3   | 3   | 3   | 3   | 2   | -   | -   | -   | 3   | 3    | -    | -    | 3    | 3    |

### Syllabus

#### Unit 1

Introduction to ARM Processor- ARM Processor–Processor Families – Features of ARM - ARM7 TDMI Architecture – Programmer’s Model – Interrupts and Exceptions – Operating Modes– Addressing Modes – ARM Instruction Set – THUMB Instruction Set – Basic ARM Assembly Language Programs-Pipelining in ARM – ARM Cortex M - A & R series.

#### Unit 2

ARM LPC2148 Microcontroller- Introduction to LPC2148 – Architecture-Advanced Microcontroller BusArchitecture-Memory Map-Phase Locked Loop - VPB Divider - Wakeup Timer - Brown-out Detector – Introduction to Embedded C Programming – Introduction to Keil IDE – GPIO – LED and Switch Interfacing – UART – Transmission and Reception – ADC -Potentiometer Interfacing.

#### Unit 3

LPC2148 Peripherals and Interfacing- External Interrupts - Device Control – Timers - Delay Timer – PWM – DMotor Speed Control – DAC – Sine Wave Generation Interfacing –Keypad V LCD- Seven Segment - Stepper Motor Temperature Sensor.

**Lab component:** Basic Assembly Language Programs - PLL configuration - GPIO programming - Analog Sensor interfacing using ADC -Serial Communication using UART - External Interrupt configuration - PWM based motorspeed control - Single stepping of Stepper Motor - Sine wave generation using DAC - Universal Timer using Timer peripheral - Digital Panel meter using Seven Segment Display- Keypad and LCD interfacing.

**Text book(s)**

Steve Furber, "ARM system On Chip Architecture", Addison Wesley, 2000.  
LPC21488 User manual, "NXP Semiconductors".

**Reference(s)**

T Martin, "The Insider's Guide to the Philips ARM7-based Microcontrollers: An Engineer's Introduction to the LPC2100 Series", Hitex, 2005.  
Tammy Noergaard, "Embedded Systems Architecture A Comprehensive Guide for Engineers and Programmers", Newnes, 2013.

**Evaluation Pattern**

| Assessment                            | Internal | External |
|---------------------------------------|----------|----------|
| Periodical 1                          | 10       |          |
| Periodical 2                          | 10       |          |
| *Continuous Assessment (Theory) (CAT) | 15       |          |
| Continuous Assessment (Lab) (CAL)     | 30       |          |
| End Semester                          |          | 35       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Computer Programming

### Course Objectives

- To learn the linear and non-linear data structures and explore its applications
- To understand representation using graph data structure
- To comprehend and employ basic sorting and searching algorithm

### Course Outcomes

**CO1:** Ability to implement linear and non-linear data structure operations using C

**CO2:** Ability to solve problems using appropriate data structures

**CO3:** Ability to analyze the algorithms and its complexity

**CO4:** Ability to employ sorting and searching algorithms using relevant data structures

### CO-PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 3   | 3   | 3   | -   | -   | -   | -   | 3   | 3    | -    | 3    | 3    | -    |
| CO2    | 3   | 3   | -   | 3   | -   | -   | -   | -   | 3   | 3    | -    | -    | 3    | -    |
| CO3    | 3   | 3   | 3   | 3   | -   | -   | -   | -   | 3   | 3    | -    | 3    | 3    | -    |
| CO4    | 3   | 3   | -   | 3   | 3   | -   | -   | -   | 3   | 3    | -    | -    | 3    | -    |

### Syllabus

#### Unit 1

Algorithm Analysis - Methodologies for Analyzing Algorithms - Asymptotic Notation - Recurrence Relations – Data Structures - Linear Data Structures (Stacks – Queues - Linked-Lists - Vectors) -Trees (Binary Search Trees - AVL trees - Red-Black trees - B-trees) - Hash-Tables (Dictionaries - Associative Arrays - Database Indexing – Caches - Sets) and Union - Find Structures.

#### Unit 2

Searching and Sorting (Insertion and Selection Sort - Quick sort - Merge sort - Heap sort - Bucket Sort and Radix Sort) - Comparison of sorting algorithms and lower bounds on sorting - Fundamental Techniques - The Greedy Method - Divide and Conquer - Dynamic Programming.

#### Unit 3

Graph Algorithms: Elementary Algorithms - Breadth-first search - Depth-first search - Topological sort - strongly connected components - Minimum Spanning Trees - Single-Source Shortest Paths - All-Pairs Shortest Paths - Maximum Flow - Network Flow and Matching - Flows and Cuts.

#### Text book(s)

Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, “Introduction to Algorithms”, Third Edition, MIT Press, 2009.

Robert Sedgewick and Kevin Wayne, “Algorithms”, Fourth Edition, Addison Wesley, 2011.

**Reference(s)**

Kurt Mehlhorn and Peter Sanders, “Data Structures and Algorithms: The Basic Toolbox”, Springer, 2008.

John V. Guttag, “Introduction to Computation and Programming using Python”, MIT Press, second edition, 2016.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Multi Variable Calculus

### Course Objectives

- To provide the basic skills required to understand, develop, and design various engineering applications involving electromagnetic fields
- To lay the foundations of electromagnetism and its practice in modern communications such as wireless, guided wave principles such as fiber optics and electronic electromagnetic structures

### Course Outcome

**CO1:** To understand the concept of electric and magnetic field in terms of mathematical descriptions.

**CO2:** To understand the phenomena of electromagnetic wave and its various parameters.

**CO3:** To apply the mathematical concepts for deriving the wave parameters and applications.

**CO4:** To apply and understand the electromagnetic concepts with numerical formulation.

### CO-PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 3   | -   | -   | 2   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO2    | 3   | 3   | -   | -   | 2   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO3    | 3   | 3   | 3   | -   | 2   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO4    | 3   | 3   | 2   | -   | 2   | -   | -   | -   | -   | -    | -    | -    | 1    | 3    |

### Syllabus

#### Unit 1

Overview of electromagnetic systems – Elements of vector calculus – scalar field – line and surface integrals – divergence and curl of vector fields – conservative field, stokes theorem- Laplacian – Electric field potential – Gauss’s Law, potential – electric field and potential – potential energy- coefficients of potential and capacitance – Poisson and Laplace equations – solutions of Laplace equations – Dielectrics.

#### Unit 2

Magnetostatics – Equation of continuity – energy density - pointing theorem- force between current loop – magnetic vector potential – boundary conditions – Time varying field – Faraday’s law and induction – Maxwell’s equations and conservation of laws – angular momentum conservation – electromagnetic waves- - propagation of electromagnetic waves in different mediums- TE, TM and hybrid modes – introduction to waveguide structures.

#### Unit 3

Historical development of computational methods – Introduction to numerical methods – boundary conditions – error computation – method of curvilinear squares – method of moments – finite element method – Monte Carlo method – FDTD simulations – selected problems in electromagnetics using python.

#### Lab Component

The students will be required to implement small scale electromagnetic situations employing matlab or python.

**Text Book(s)**

Matthew N.O. Sadiku & S.V. Kulkarni, "Principles of Electromagnetics", Oxford University Press, Sixth Edition 2015, ISBN: 9780199461851.

Matthew N.O. Sadiku, "Numerical Techniques in Electromagnetics with MATLAB", CRC Press, 2009, eISBN: 978-1-4398-8304-4.

**Reference(s)**

Karl E. Lonngren, Sava V. Savov, Randy J. Jost, "Fundamentals of Electromagnetics with MATLAB", SciTech Publishing, Inc., 2007, Second Edition.

JaanKiusalaas, "Numerical Methods in Engineering with Python 3", Cambridge University Press, 2013, ISBN 978-1-107-0338.

**Evaluation Pattern**

| Assessment                            | Internal | External |
|---------------------------------------|----------|----------|
| Periodical 1                          | 10       |          |
| Periodical 2                          | 10       |          |
| *Continuous Assessment (Theory) (CAT) | 15       |          |
| Continuous Assessment (Lab) (CAL)     | 30       |          |
| End Semester                          |          | 35       |

•CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):**Linear Algebra

### Course Objectives

- To understand the fundamental characteristics of signals and systems
- To understand signals and systems in terms of both the time and frequency domains
- To introduce the frequency domain concepts and filter design in signal processing applications

### Course Outcomes

**CO1:** Able to represent the basic continuous time and discrete time signals and systems

**CO2:** Able to apply frequency domain transformations on different signals

**CO3:** Able to design a digital filters for the given specifications

**CO4:**Able to realize a filters with the suitable structures and develop simple DSP based systems

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 2   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |
| CO2    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |
| CO3    | 3   | 2   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | 2    |
| CO4    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | 2    |

### Syllabus

#### Unit 1

Basic signals: unit step, unit impulse, sinusoidal and complex exponential signals - Types of signals- Basic operations on signals-system properties-Time Domain characterization of continuous time and discrete time LTI system-Convolution Integral-Convolution sum-Analysis of LTI system described by differential and difference equations.

#### Unit 2

Discrete Fourier transforms: Fourier Transform, Fourier analysis of discrete time signals and systems: Discrete time Fourier series – Discrete Time Fourier Transform - properties of DTFT – Introduction to DFT- properties of DFT – linear filtering methods based on DFT – FFT algorithms.

#### Unit 3

Digital filters: Introduction, specifications of practical filters, Characteristics of commonly used analog filters – IIR filters: design by approximation of derivatives – impulse invariance and bilinear transformation – Butterworth filter- frequency transformations for analog and digital filters, Structures for IIR systems. FIR filters: symmetric and anti-symmetric FIR filters – design of linear phase FIR filter using windows –Structures for FIR systems – direct form structures, Linear phase and cascade form structures.

#### Text book(s)

*Simon Haykin, Barry Van Veen, "Signals and Systems", Second Edition, John Wiley and Sons, 2007.*

*Alan V. Oppenheim, Alan S. Wilsky, S, Hamid Nawab, "Signals and Systems", Prentice Hall India private Limited, Second Edition, 1997.*

**Reference(s)**

John G Proakis, G. Manolakis, “Digital Signals Processing Principles, Algorithms, Applications”, Prentice Hall India Private Limited, Fourth Edition, 2007.

Sanjit K. Mitra, “Digital Signal Processing: A computer based approach”, Tata McGraw Hill Publishing Company Limited, Fourth Edition, 2010.

Allen V. Oppenheim, Ronald W. Schaffer, “Discrete time Signal processing”, Prentice Hall India Private Limited, Third Edition, 2013.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports



**Course objectives**

To understand the concepts of basic probability and random variables.  
 To understand some standard distributions and apply to some problems.  
 To understand the concepts of random process, stationarity and autocorrelation functions.  
 To understand markov process and markov chain and related concepts.

**Course Outcomes**

**CO1:** Understand the basic concepts of probability and probability modeling.  
**CO2:** Gain knowledge about statistical distributions of one and two dimensional random variables and correlations  
**CO3:** Understand the basic concepts of stochastic processes and the stationarity.  
**CO4:** Understand the purpose of some special processes  
**CO5:** Gain knowledge about spectrum estimation and spectral density function

**CO-PO Mapping**

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 2   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO2    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO3    | 3   | 3   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO4    | 3   | 2   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO5    | 2   | 2   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |

**Module I**

Review of probability concepts - conditional probability- Bayes theorem.

**Random Variable and Distributions:** Introduction to random variable – discrete and continuous random variables and its distribution functions- mathematical expectations – moment generating function and characteristic function.

**Module II**

Binomial, Poisson, Geometric, Uniform, Exponential, Normal distribution functions (moment generating function, mean, variance and simple problems) – Chebyshev’s theorem.

**Module III****Stochastic Processes:**

General concepts and definitions - stationary in random processes - strict sense and wide sense stationary processes - autocorrelation and properties- special processes – Poisson points, Poisson and Gaussian processes and properties- systems with stochastic inputs - power spectrum- spectrum estimation, ergodicity –Markov process and Markov chain, transition probabilities, Chapman Kolmogrov theorem, limiting distributions classification of states. Markov decision process.

**Text Book(s)**

*Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, (2005) John Wiley and Sons Inc.*

*A. Papoulis, and Unnikrishna Pillai, “Probability, Random Variables and Stochastic Processes”, Fourth Edition, McGraw Hill, 2002.*

**Reference Book(s)**

*J. Ravichandran, "Probability and Random Processes for Engineers", First Edition, IK International, 2015.*  
*Scott L. Miller, Donald G. Childers, "Probability and Random Processes", Academic press, 2012.*

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):**Linear Algebra

### Course Objectives

- To get familiarized with time and frequency domain representations of signals and systems
- To get familiarized with frequency response of a systems
- To get familiarized with designing of digital filters

### Course Outcomes

**CO1:** Able to understand the time and frequency domain representation of discrete time signals

**CO2:** Able to analyze the time and frequency domain response of discrete time systems

**CO3:** Able to design FIR and IIR filter for the given specifications and simulate the frequency response

**CO4:** Able to design, simulate and analyze a DSP based systems for simple applications

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | -   | -   | -   | 3   | -   | -   | -   | -   | -    | -    | -    | 3    | -    |
| CO2    | 3   | 3   | -   | -   | 3   | -   | -   | -   | -   | -    | -    | -    | 3    | -    |
| CO3    | 2   | 3   | 3   | -   | 3   | -   | -   | -   | -   | -    | -    | -    | 3    | -    |
| CO4    | 2   | 3   | 3   | -   | 3   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |

### Syllabus

1. Representation of Sinusoidal Signals and Spectrum.
2. Basic operations on signal.
3. LTI systems – convolutions.
4. Fourier Series Representation of Periodic signals.
5. Time and Frequency Response of LTI Systems.
6. Sampling.
7. Properties of DFT – circular convolution.
8. Efficient computation of DFT algorithms.
9. FIR Filter Design and Analysis.
10. IIR Filter Design and Analysis.
11. Term Project.

### Text book(s)

*John G. Proakis, "Digital Signal Processing: Principles Algorithms and Applications Using Matlab", Pearson Education India.*

*Mitra, Sanjit Kumar, and YonghongKuo, "Digital Signal Processing: A Computer-based Approach", 2nd edition, Tata McGraw-Hill.*

### Reference(s)

*Alan V, Oppenheim, Ronald W., Schaffer A., "Digital Signal Processing", PHI Publishers.*

### Evaluation Pattern

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| *Continuous Assessment (CA) | 80       |          |
| End Semester                |          | 20       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.

**Pre Requisite(s):**Computer Programming

### Course Objectives

- To develop programming skills with a systematic approach in organizing and debugging programs in C
- To implement data structures for problem solving
- To implement and analyze the searching algorithms in the context of specific engineering problems

### Course Outcomes

**CO1:** Ability to understand a systematic approach to organizing, writing and debugging C programs

**CO2:** Ability to implement linear and non-linear data structure operations using C programs

**CO3:** Ability to solve problems implementing appropriate data structures

**CO4:** Ability to implement sorting and searching algorithms using relevant data structures

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 3   | 3   | 3   | -   | -   | -   | -   | 3   | 3    | -    | 3    | 3    | -    |
| CO2    | 3   | 3   | -   | 3   | -   | -   | -   | -   | 3   | 3    | -    | -    | 3    | -    |
| CO3    | 3   | 3   | 3   | 3   | -   | -   | -   | -   | 3   | 3    | -    | 3    | 3    | -    |
| CO4    | 3   | 3   | -   | 3   | 3   | -   | -   | -   | 3   | 3    | -    | -    | 3    | -    |

### Syllabus

- Complexity of algorithms
- Probabilistic Analysis and Randomized Algorithms
- Sorting
  - Heap Sort
  - Quick Sort
  - Sorting in linear time
- Data structures
  - Elementary data structures
  - Hash tables
  - Binary search trees
- Algorithms
  - Dynamic programming
  - Greedy algorithms

### Text Book(s)

Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", Third Edition, MIT Press, 2009.

Robert Sedgewick and Kevin Wayne, "Algorithms", Fourth Edition, Addison Wesley, 2011.

### Reference(s)

Kurt Mehlhorn and Peter Sanders, "Data Structures and Algorithms: The Basic Toolbox", Springer, 2008.

Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", Second Edition, Pearson Education, 1996.

### Evaluation Pattern

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| *Continuous Assessment (CA) | 80       |          |
| End Semester                |          | 20       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Course Objectives**

- To study the nature and facts about environment
- To appreciate the importance of environment by assessing its impact on the human world
- To study the integrated themes and biodiversity, pollution control and waste management

**Course Outcomes**

**CO1:** Ability to understand aspects of nature and environment

**CO2:** Ability to analyse impact of environment on human world

**CO3:** Ability to comprehend pollution control and waste management

**CO – PO Mapping**

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | -   | -   | -   | -   | -   | 3   | 2   | 3   | -   | -    | -    | -    | -    | -    |
| CO2    | -   | -   | -   | -   | -   | 3   | 2   | 3   | -   | -    | -    | -    | -    | -    |
| CO3    | -   | -   | -   | -   | -   | 3   | 2   | 3   | -   | -    | -    | -    | -    | -    |

**Syllabus****Unit 1**

Over view of the global environment crisis – Biogeochemical cycles – Climate change and related international conventions and treaties and regulations – Ozone hole and related International conventions and treaties and regulations – Overpopulation – energy crisis – Water crisis – ground water hydrogeology – surface water resource development.

**Unit 2**

Ecology, biodiversity loss and related international conventions – treaties and regulations – Deforestation and land degradation – food crisis – water pollution and related International and local conventions – treaties and regulations – Sewage domestic and industrial and effluent treatment – air pollution and related international and local conventions – treaties and regulations – Other pollution (land, thermal, noise).

**Unit 3**

Solid waste management (municipal, medical, e-waste, nuclear, household hazardous wastes) – environmental management – environmental accounting – green business – eco-labelling – environmental impact assessment – Constitutional – legal and regulatory provisions – sustainable development.

**Text Book(s)**

R. Rajagopalan, “Environmental Studies – From Crisis to Cure”, Oxford University Press, 2005, ISBN 0-19-567393-X.

**Reference(s)**

G.T.Miller Jr., “Environmental Science”, 11<sup>th</sup> Edition, Cengage Learning Pvt. Ltd., 2008.

Benny Joseph, “Environmental Studies”, Tata McGraw-Hill Publishing company Limited, 2008.

**Evaluation Pattern**

| Assessment  | Internal | External |
|-------------|----------|----------|
| Online Test | -        | 100      |
|             |          | P/F      |



## SEMESTER IV

19CCE211

EMBEDDED COMPUTING

L-T-P-C: 3-0-0-3

**Pre Requisite(s):** Microcontrollers and Interfacing

### Course Objectives

- To identify the difference between ARM7 and Cortex M family of Microprocessors
- To apply the knowledge of Embedded C Programming for configuring various peripherals of a microcontroller
- To develop basic understanding of Real Time Operating Systems
- To learn to design and develop Microcontroller based solutions for solving real world problems

### Course Outcomes

**CO1:** Able to identify the advanced features of Cortex M3 Processor

**CO2:** Able to analyze MSP432 Peripherals and its configuration using Embedded C

**CO3:** Able to implement a basic Application using Real Time Operating System

**CO4:** Able to design and develop embedded systems using MSP432 Microcontroller

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | -   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO2    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO3    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO4    | 3   | 3   | 3   | 3   | 2   | 2   | 2   | 2   | 3   | 3    | -    | -    | 3    | 3    |

### Syllabus

#### Unit 1

ARM Cortex M3 Processor: Overview of the Cortex-M3 - Registers – Special Registers -Operation Modes – Built-in Nested Vectored Interrupt Controller - Memory Map – Bus Interfaces - Instruction Set - Memory Systems- Cortex-M3 Implementation overview – Exceptions - Nested Vectored Interrupt Controller and Interrupt Control - Interrupt Behavior - Cortex-M3 Programming - Advanced Programming Features and System Behavior - The Memory Protection Unit - Other Cortex-M3 Features - Debug Architecture - Debugging Components.

#### Unit 2

MSP432 Architecture and Peripherals - Introduction to MSP432 Architecture – Memory Map – Clock System – Power Control Manager – Power Mode – DMA – Digital Input Output – Enhanced Universal Serial Communication Interface – Precision ADC – Programming MSP432 using Energia IDE.

#### Unit 3

Introduction to FreeRTOS and Programming: Introduction to RTOS – Task States – Semaphores – Scheduling Preemptive - Rate Monotonic – Earliest Deadline First - Inter Task Communication – Message Queue – MailBox – Pipes – Introduction to FreeRTOS – Task Management – Interrupt Management – Queue Management.

**Text book(s)**

Joseph Yiu, "The Definitive Guide to the ARM Cortex M3", Second Edition, Elsevier Inc., 2010.  
Muhammad Ali Mazidi, Shujen Chen, Sepehr Naimi, "TI MSP432 ARM Programming for Embedded Systems", Volume 4, 2016.

**Reference(s)**

Jean J. Labrosse, "MicroC OS II: The Real Time Kernel", 2002.  
Richard Barry, "Using the FreeRTOS Real Time Kernel ARM Cortex", M3 Edition, Real Time Engineers Ltd., 2010.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports



**Pre Requisite(s):**Signal Processing

### Course Objectives

- To understand the signal processing algorithms, filter design methods, and signal processing techniques
- To provide the design engineers with the tools necessary for efficient implementation of digital transceivers
- To focus on the multirate systems arising in the communications, especially wireless and software defined radios
- To understand software radio design and implement Multirate DSP, RF front-ends, direct digital synthesis of modulated waveforms, A/D and D/A conversion

### Course Outcomes

**CO1:** Able to design a resampling architecture for digital RF front end systems

**CO2:** Able to design efficient filter implementations for baseband transceivers

**CO3:** Able to design multirate systems for carrier, phase and timing recovery for communication receivers

**CO4:** Able to implement software radio for wireless systems and sub-systems

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 3   | 2   | 2   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | 2    |
| CO2    | 3   | 3   | 2   | 2   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | 2    |
| CO3    | 3   | 3   | 2   | 3   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | 2    |
| CO4    | 3   | 3   | 2   | 2   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | 2    |

### Syllabus

#### Unit 1

Fundamentals of Multirate Signal Processing – Nyquist and Square root Nyquist Filter – Systems using resampling filter - Quadrature Mirror Filters (QMF) - Theory and Application - Wavelet for multirate signal processing.

#### Unit 2

Polyphase FIR filter – Resampling Filter - Half-band Filters – Dyadic filter – Arbitrary Sampling Rate Conversion - Recursive polyphase filter – Cascade Integrator Comb Filter (CIC) - Cascade and multiple stage filters - Analog to Digital and Digital to Analog converters for SDR.

#### Unit 3

Application in communication systems – Conventional Digital down converters (DDC) - Aliasing DDC - Timing recovery in digital demodulation - Carrier recovery and phase recovery - Introduction to software-defined radio - Review of telecommunication concepts and systems - Analog and Digital Communication System - Front-end RF system - Link Budgets – noise - C/N and S/N ratios - Digital filtering - Signal recovery - Baseband and Band pass Sampling - Complete SDR systems - Future trends in SDR.

#### Text book(s)

*Fredric J Harris, “Multirate Signal Processing for Communication Systems”, Pearson Education, 2004.*

*BehrouzFarhang-Boroujeny, “Signal Processing Techniques for Software Radios”, Lulu Publishing House, 2008.*

*Jeffrey H Reed, “Software Radio: A Modern Approach to Radio Engineering”, Prentice Hall PTR, 2002.*

**Reference(s)**

Vaidyanathan P P, "Multirate Systems and Filter Banks", Prentice Hall Inc., 1993.

N. J. Fliege, "Multirate Digital Signal Processing - Multirate Systems", Filter Banks and Wavelets, John Wiley, 1994.

Tony J. Roupael, "RF and Digital Signal Processing for Software-Defined Radio: A Multi-Standard Multi-Mode Approach", Elsevier Inc., 2009.

Walter Tuttlebee, "Software Defined Radio: Origins, Drivers and International Perspectives", John Wiley and Sons Ltd, 2002.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Nil

### Course Objectives

- To introduce mathematical methods for design of machine learning algorithms
- To provide an overview of cluster analysis process and cluster quality evaluation techniques
- To enable design and performance evaluation of classifiers for typical classification problems
- To enable design of frequent itemset mining system for typical solve market-basket analysis problems

### Course Outcomes

**CO1:** Able to generate, analyze and interpret data summaries

**CO2:** Able to carry out analysis on machine learning algorithms

**CO3:** Able to design and implement classifiers for machine learning applications

**CO4:** Able to design and implement frequent itemset mining systems

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO2    | -   | 3   | 2   | -   | 2   | -   | -   | -   | -   | -    | -    | -    | 3    | -    |
| CO3    | -   | 2   | 3   | 2   | 2   | -   | -   | -   | -   | -    | -    | -    | 3    | -    |
| CO4    | -   | 2   | 3   | 2   | 2   | -   | -   | -   | -   | -    | -    | -    | 3    | -    |

### Syllabus

#### Unit 1

Measuring the central tendency - measuring the dispersion of data - graphic displays of basic descriptive data Summaries - Missing values - noisy data- data cleaning as a process - Data integration - data transformation - Data cube aggregation - attribute subset selection - dimensionality reduction.

#### Unit 2

Cluster Analysis using k-Means - k-Medoids - single linkage - complete linkage - UPGMA and expectation Maximization - Assessing clustering tendency - determining the number of clusters - measuring clustering quality k-nearest neighbor - Bayes - decision tree and Support Vector Machines (SVM) classifiers - Classifier accuracy Measures - evaluating the accuracy of a Classifier.

#### Unit 3

Efficient and Scalable Frequent Itemset Mining Methods- Mining Various Kinds of Association Rules- From Association Mining to Correlation Analysis- Constraint-Based Association Mining.

**Lab Component:** Experiments on machine learning and artificial intelligence algorithms using Matlab / Python.

#### Text book(s)/

Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining: Concepts and Techniques", 3rd Edition, Morgan Kaufmann Publishers (Elsevier), 2011.

K.P Soman, R. Loganathan, V. Ajay, "Machine Learning with SVM and other Kernel Methods", PHI Learning Private Ltd., New Delhi, 2009.

**Reference(s)**

Earl Gose, Richard Johnsonbaugh, Steve Jost, "Pattern Recognition and Image Analysis", Pearson Education India, 2015.

Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.

**Evaluation Pattern**

| Assessment                               | Internal | External |
|--|----------|----------|
| Periodical 1                             | 15       |          |
| Periodical 2                             | 15       |          |
| *Continuous Assessment (Theory)<br>(CAT) | 20       |          |
| Continuous Assessment (Lab)<br>(CAL)     | 30       |          |
| End Semester                             |          | 35       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.

**Pre Requisite(s):** Nil

**Course Objectives**

- To introduce the concepts of amplitude modulations and their spectral characteristics
- To understand the concepts of angle modulations and their spectral characteristics
- To study the effect of noise on communication systems
- To understand the concepts of analog to digital conversion

**Course Outcomes**

**CO1:** Ability to understand the basic principles of signal modulation

**CO2:** Ability to analyze the time domain and frequency domain representation of amplitude and angle modulations

**CO3:** Able to analyze the effect of noise on analog communication systems

**CO4:** Able to apply the concepts of modulation schemes in the design of communication systems

**CO – PO Mapping**

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | -    |
| CO2    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | -    |
| CO3    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | -    |
| CO4    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | -    |

**Syllabus**

**Unit 1**

Amplitude Modulation - Amplitude modulation - DSB-SC -SSB modulation and demodulation - Introduction to vestigial sideband modulation - Implementation of AM modulator and demodulator - Super heterodyne receiver.

**Unit 2**

Angle Modulation - Angle modulation - Introduction and representation - Spectral characteristics of angle Modulation - Implementation of modulator and demodulator for angle modulation.

**Unit 3**

Noise Analysis and Analog to Digital conversion -Random process basic concepts and linear systems - Gaussianwhite process -Narrow band noise and filtering - Effect of noise in AM system - Effect of noise in FM system - Analog to digital conversion - Waveform coding, PCM - DPCM, Delta modulation.

**Text book(s)**

*John. G. Proakis, MasoudSalehi, "Fundamentals of Communication Systems", Pearson Education, 6th edition, 2011.*

*Simon Haykin, "Communication Systems", John Wiley and Sons, 4th edition, 2001.*

**Reference(s)**

Bruce Carlson, Paul.B. Crilly, Janet.C.Ruteledge, "Communication Systems", McGraw-Hill, 1993, Fourth Edition.

Rodger. E. Ziemer, William. H. Tranter, "Principle of Communication", John Wiley, 1998, Fifth Edition.

**Evaluation Pattern:**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.

**Course Objectives**

- To understand the concept of search space and optimality for solutions of engineering problems.
- To understand some computation techniques for optimizing single variable functions.
- To carry out various computational techniques for optimizing severable variable functions.

**Course Outcomes:**

**CO1:** Understand different types of Optimization Techniques in engineering problems. Learn Optimization methods such as Bracketing methods, Region elimination methods, Point estimation methods.

**CO2:** Learn Optimizations Techniques in single variables problems.

**CO3:** Learn unconstrained Optimizations Techniques in single variables problems

**CO4:** Learn constrained optimization techniques and Kuhn-Tucker conditions

**CO-PO Mapping**

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |
| CO1    | 2   | 2   | 1   | 1   |     |     |     |     |     |      |      |      |
| CO2    | 1   | 2   | 3   |     | 1   |     |     |     |     |      |      |      |
| CO3    | 2   | 2   | 2   |     | 2   |     |     |     |     |      |      |      |
| CO4    | 2   | 2   | 1   | 1   | 1   |     |     |     |     |      |      |      |

**Syllabus:**

Introduction: Optimization - optimal problem formulation, engineering optimization problems, optimization algorithms, numerical search for optimal solution.

Single Variable optimization: Optimality criteria, bracketing methods - exhaustive search method, bounding phase method- region elimination methods - interval halving, Fibonacci search, golden section search, point estimation method- successive quadratic search, gradient based methods.

Multivariable Optimization: Optimality criteria, unconstrained optimization - solution by direct substitution, unidirectional search – direct search methods evolutionary search method, simplex search method, Hook-Jeeves pattern search method, gradient based methods – steepest descent, Cauchy’s steepest descent method, Newton’s method, conjugate gradient method - constrained optimization. Kuhn-Tucker conditions.

**TEXT BOOKS:**

S.S. Rao, “Optimization Theory and Applications”, Second Edition, New Age International (P) Limited Publishers, 1995.

**REFERENCES:**

Kalyanmoy Deb, “Optimization for Engineering Design Algorithms and Examples”, Prentice Hall of India, New Delhi, 2004.

Edwin K.P. Chong and Stanislaw H. Zak, “An Introduction to Optimization”, Second Edition, Wiley-Interscience Series in Discrete Mathematics and Optimization, 2004.

M. Asghar Bhatti, “Practical Optimization Methods: with Mathematics Applications”, Springer Verlag Publishers, 2000.

### Evaluation Pattern

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports



**Pre Requisite(s):** Nil

### Course Objectives

- To Develop hands on experience in interfacing external peripherals with a given microcontroller
- To implement MSP43x Internal Peripheral configuration and programming
- To Design and Develop MSP43x based solution for Embedded Control

### Course Outcomes

**CO1:** Able to analyze various real world sensors and actuators that can be interfaced with a microcontroller

**CO2:** Able to develop programming skills for configuring MSP43x on-chip peripherals

**CO3:** Able to implement Task Management in a Multi Tasking System using FreeRTOS

**CO4:** Able to design and develop an embedded computing platform using MSP43x Microcontroller

### CO-PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | -   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO2    | 3   | 2   | 3   | -   | 2   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO3    | 3   | -   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO4    | 3   | 3   | 3   | 3   | 2   | 2   | 2   | -   | -   | -    | -    | -    | 3    | 3    |

### Syllabus

1. GPIO Interfacing using MSP43x – Led, Switch.
2. Motor Direction Control.
3. LCD Interfacing.
4. UART Transmission and Reception.
5. Generating Delay using SysTick Timer.
6. Toggling LED using Timer32.
7. Input Capture operation using TimerA.
8. External Interrupt Programming.
9. ADC Programming – Temperature Sensor Interface.
10. Sine Wave Generation using DAC.
11. Task Creation and Management using FreeRTOS.
12. Intertask Communication using FreeRTOS.

### Text book(s)

Muhammad Ali Mazidi, Shujen Chen, Sepehr Naimi, "TI MSP432 ARM Programming for Embedded Systems", Volume 4, 2016.

Richard Barry, "Using the FreeRTOS Real Time Kernel ARM Cortex-M3 Edition", Real Time Engineers Ltd., 2010.

**Reference(s)**

Jean J. Labrosse, "MicroC OS II: The Real Time Kernel", 2002.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| *Continuous Assessment (CA) | 80       |          |
| End Semester                |          | 20       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):**Signal Processing Lab

### Course Objectives

- To provide a comprehensive introduction to the study of signal processing techniques in Communication systems
- To address implementation concerns and architectures in signal processing algorithms for digital transceivers
- To facilitate design of advanced and customized signal processing routines for challenges in design of communication systems

### Course Outcomes

**CO1:** Able to understand and analyze the modern signal processing techniques

**CO2:** Able to develop signal processing algorithms for specific and domain based applications

**CO3:** Able to develop mathematical models based on theoretical foundations for communication engineering Problems

**CO4:** Able to do analyze trade offs of various subsystem parameters

### CO-PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 3   | -   | 3   | 3   | -   | -   | -   | 3   | 3    | -    | 2    | 3    | -    |
| CO2    | 3   | 3   | 3   | 3   | 3   | -   | -   | -   | 3   | 3    | -    | 2    | 3    | 2    |
| CO3    | 3   | 3   | 3   | 3   | 3   | -   | -   | -   | 3   | 3    | -    | 2    | 3    | 2    |
| CO4    | 2   | 2   | -   | 3   | 3   | -   | -   | -   | 3   | 3    | -    | 2    | 3    | 2    |

### Syllabus

#### (Preferred Python)

1. Sampling – low pass and band limited.
2. Design and analysis of digital filters – optimization approach.
3. Interpolation and decimation – time and frequency domain analysis.
4. Fractional rate conversion.
5. Realization of resampling filters.
6. Polypohase and CIC structures.
7. Wavelet using resampling filters.
8. Deterministic and stochastic simulations.
9. Modeling of errors due to sampling and quantization– choice of simulation sampling frequency.
10. Sampling and generation of low pass and band limited signals.
11. Baseband representation of linear and non-linear band pass signals and systems– time varying systems.
12. Simulation of random process and noise sources.

#### Text book(s)

*Fredric J Harris, "Multirate Signal Processing for Communication Systems", Pearson Education, 2004.*

*BehrouzFarhang-Boroujeny, "Signal Processing Techniques for Software Radios", Lulu Publishing House, 2008.*

**Reference(s)**

Paolo Prandoni, Martin Vetterli, "Signal Processing for Communications", EPFL Press, 2008.

M. Schiff, "Introduction to Communication Systems Simulation", Artech House, 2006.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| *Continuous Assessment (CA) | 80       |          |
| End Semester                |          | 20       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.

**Course Outcome**

CO 1 - Soft Skills: At the end of the course, the students would have developed self-confidence and positive attitude necessary to compete and challenge themselves. They would also be able to analyse and manage their emotions to face real life situations.

CO 2 - Soft Skills: Soft Skills: At the end of the course, the students would hone their presentation skills by understanding the nuances of content creation, effective delivery, use of appropriate body language and the art of overcoming nervousness to create an impact in the minds of a target audience.

CO 3 - Aptitude: At the end of the course, the student will have acquired the ability to analyze, understand and classify questions under arithmetic, algebra and logical reasoning and solve them employing the most suitable methods. They will be able to analyze, compare and arrive at conclusions for data analysis questions.

CO 4 – Verbal: At the end of the course, the students will have the ability to dissect polysyllabic words, infer the meaning, inspect, classify, contextualise and use them effectively.

CO 5 - Verbal: At the end of the course, the students will have the ability to understand the nuances of English grammar and apply them effectively.

CO 6 – Verbal: At the end of the course, the students will have the ability to identify, analyse and interpret relationship between words and use the process of elimination to arrive at the answer. They will also have the ability to judge, evaluate, summarise, criticise, present and defend their perceptions convincingly.

**CO-PO Mapping:**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1   |     |     |     |     |     |     |     | 2   | 3   | 3    |      | 3    |
| CO2   |     |     |     |     |     |     |     |     | 2   | 3    |      | 3    |
| CO3   |     | 3   |     | 2   |     |     |     |     |     |      |      |      |
| CO4   |     |     |     |     |     |     |     |     |     | 3    |      | 3    |
| CO5   |     |     |     |     |     |     |     |     |     | 3    |      | 3    |
| CO6   |     |     |     |     |     |     |     |     | 3   | 3    |      | 3    |

Soft skills and its importance: Pleasure and pains of transition from an academic environment to work - environment. Need for change. Fears, stress and competition in the professional world. Importance of positive attitude, Self motivation and continuous knowledge upgradation.

Self-confidence: Characteristics of the person perceived, characteristics of the situation, characteristics of the perceiver. Attitude, values, motivation, emotion management, steps to like yourself, positive mental attitude, assertiveness.

Presentations: Preparations, outlining, hints for efficient practice, last minute tasks, means of effective presentation, language, gestures, posture, facial expressions, professional attire.

Vocabulary building: A brief introduction into the methods and practices of learning vocabulary. Learning how

to face questions on antonyms, synonyms, spelling error, analogy, etc. Faulty comparison, wrong form of words and confused words like understanding the nuances of spelling changes and wrong use of words. Listening skills: The importance of listening in communication and how to listen actively.

Prepositions, articles and punctuation: A experiential method of learning the uses of articles and prepositions in sentences is provided.

Problem solving level I: Number system; LCM &HCF; Divisibility test; Surds and indices; Logarithms; Ratio, proportions and variations; Partnership;

Problem solving level II: Time speed and distance; work time problems;

Data interpretation: Numerical data tables; Line graphs; Bar charts and Pie charts; Caselet forms; Mix diagrams; Geometrical diagrams and other forms of data representation.

Logical reasoning: Family tree; Deductions; Logical connectives; Binary logic; Linear arrangements; Circular and complex arrangement; Conditionalities and grouping; Sequencing and scheduling; Selections; Networks; Codes; Cubes; Venn diagram in logical reasoning; Quant based reasoning; Flaw detection; Puzzles; Cryptogrihms.

### **TEXTBOOKS**

*A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.*

*Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.*

*Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.*

*The Hard Truth about Soft Skills, by Amazone Publication.*

*Quantitative Aptitude by R. S. Aggarwal, S. Chand*

*Quantitative Aptitude – Abijith Guha, TMH.*

*Quantitative Aptitude for Cat - Arun Sharma. TMH.*

### **REFERENCES:**

*Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova.*

*More Games Teams Play, by Leslie Bendaly, McGraw Hill Ryerson.*

*The BBC and British Council online resources*

*Owl Purdue University online teaching resources*

*www.the grammarbook.com - online teaching resources www.englishpage.com- online teaching resources and other useful websites.*

**Course Objectives**

- To know about Indian constitution
- To know about central and state government functionalities in India
- To know about Indian society

**Course Outcomes**

**CO1:** Understand the functions of the Indian government

**CO2:** Understand and abide the rules of the Indian constitution

**CO3:** Understand and appreciate different culture among the people

**CO-PO Mapping**

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | -   | -   | -   | -   | -   | 3   | 2   | 3   | -   | -    | -    | -    | -    | -    |
| CO2    | -   | -   | -   | -   | -   | 3   | 2   | 3   | -   | -    | -    | -    | -    | -    |
| CO3    | -   | -   | -   | -   | -   | 3   | 2   | 3   | -   | -    | -    | -    | -    | -    |

**Syllabus****Unit 1**

Historical Background – Constituent Assembly Of India – Philosophical Foundations Of The Indian Constitution – Preamble – Fundamental Rights – Directive Principles Of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies For Citizens.

**Unit 2**

Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.

**Unit 3**

State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts.

**Text Book(s)**

*Durga Das Basu, "Introduction to the Constitution of India", Prentice Hall of India, New Delhi.*

*R.C.Agarwal, (1997) "Indian Political System", S.Chand and Company, New Delhi.*

**Reference(s)**

*Sharma, Brij Kishore, "Introduction to the Constitution of India", Prentice Hall of India, New Delhi.*

**Evaluation Pattern**

| Assessment  | Internal | External |
|-------------|----------|----------|
| Online Test | -        | 100      |
|             |          | P/F      |

## SEMESTER V

19CCE301

INTERNET OF THINGS

L-T-P-C: 3-0-0-3

**Pre Requisite(s):** Nil

### Course Objectives

- To introduce different architectures used for connected smart devices
- To study various protocols used in Internet of Things environment
- To Design and Develop Internet of Things based solution for real world problems

### Course Outcomes

**CO1:** Able to understand the basic architecture of Internet of Things based Devices

**CO2:** Able to analyze light weight protocols implemented for connected devices

**CO3:** Able to develop firmware for controlling wireless devices

**CO4:** Able to design and develop Smart Devices using IoT

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | -   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO2    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO3    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO4    | 3   | 3   | 3   | 3   | 2   | 2   | -   | -   | -   | -    | -    | -    | 3    | 3    |

### Syllabus

#### Unit 1

Genesis of IoT -IoT and Digitization - IoT Impact - Convergence of IT and IoT - IoT Challenges -IoT Network Architecture and Design - Drivers Behind New Network Architectures - Comparing IoT Architectures - A Simplified IoT Architecture -The Core IoT Functional Stack -IoT Data Management and Compute Stack.

#### Unit 2

Smart Objects - The “Things” in IoT – Sensors –Actuators - and Smart Objects - Sensor Networks - Connecting Smart Objects - Communications Criteria -IoT Access Technologies -IP as the IoT Network Layer - The Business Case for IP - The need for Optimization -Optimizing IP for IoT - Profiles and Compliances.

#### Unit 3

Application Protocols for IoT - The Transport Layer -IoT Application Transport Methods - Data and Analytics for IoT - An Introduction to Data Analytics for IoT - Machine Learning, Big Data Analytics Tools and Technology -Edge Streaming Analytics, Network Analytics.

#### Unit 4

RaspberryPi Board - Hardware Layout - Operating Systems on RaspberryPi - Configuring RaspberryPi - Programming RaspberryPi with Python - Wireless Temperature Monitoring System Using Pi - DS18B20 Temperature Sensor -Connecting Raspberry Pi via SSH - Accessing Temperature from DS18B20 sensors - Remote access to RaspberryPi - Smart and Connected Cities - An IoT Strategy for Smarter Cities - Smart City IoT Architecture - Smart City Security Architecture - Smart City Use-Case Examples.



**Text book(s)**

David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", First Edition, Cisco Press, 2017.  
Adrian McEwen, HakinCassimally, "Designing The Internet of Things", First Edition, Wiley, 2014.

**Reference(s)**

Raj Kamal, "Internet of Things: Architecture and Design Principles", First Edition, McGraw Hill Education, 2017.  
Peter Waher, "Mastering Internet of Things: Design and create your own IoT applications using Raspberry Pi 3", First Edition, Packt Publishing, 2018.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.

**Pre Requisite(s):** Communication Theory

### Course Objectives

- Understand the fundamental principles of digital modulation and demodulation methods
- Quantify the impact of noise and channel impairments on digitally modulated signals
- Design digital signals and optimum receivers to combat the impact of noise and channel impairments
- Understand and appreciate the techniques to make digital modulation and demodulation methods power efficient, bandwidth efficient, and suitable for hardware implementation

### Course Outcomes

**CO1:** Able to understand the fundamental principles of digital modulation and demodulation methods

**CO2:** Able to quantify the impact of noise and channel impairments on digitally modulated signals

**CO3:** Able to design digital signals and optimum receivers to combat the adverse impact of noise and channel impairments

**CO4:** Able to choose and apply efficient digital modulation schemes for a given channel type

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1    | 3   | -   | 3   | 3   | -   | -   | -   | -   | -   | -    | -    | 3    | 3    | -    |
| CO2    | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -   | -    | -    | 3    | 3    | 2    |
| CO3    | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -   | -    | -    | 3    | 3    | 2    |
| CO4    | -   | 3   | 3   | 3   | -   | -   | -   | -   | -   | -    | -    | 3    | 3    | 2    |

### Syllabus

#### Unit 1

Signal Space Representation of Waveforms - GS orthogonalization - Bandpass and lowpass orthonormal basis - Line

Coding - Unipolar -Polar;Bipolar – RZ – NRZ – Manchester.

#### Unit 2

Digital Carrier Modulation - Memoryless carrier modulation – ASK – PSK – QAM - FSK - Carrier modulation with

memory – CPFSK – MSK – GMSK - OQPSK - $\pi/4$ -QPSK - Differential encoding – DPSK, DQPSK - Power spectra of digitally modulated signals -Optimum ReceiverDesign for AWGN Channels - Correlation-type and matched –filter- type demodulators - MAP and ML detectors - Optimum coherent receiversfor AWGN channels - Probability of error– union bound.

#### Unit 3

Signaling and Optimum Receiver DesignforBandlimited Channels - Inter-Symbol Interference (ISI) - Signal design

for bandlimited channels –Nyquist criterion for no ISI - Optimum detection for channels with ISI and AWGN - Equalization.

**Text book(s)**

John G. Proakis and MasoudSalehi, "Digital Communications", McGraw-Hill Higher Education, Fifth Edition, 2008.

Simon Haykin, "Digital Communication Systems", John Wiley & Sons, 2014.

**Reference(s)**

John G. Proakis, MasoudSalehi and Gerhard Bauch, "Contemporary Communication Systems Using MATLAB", Cengage Learning India, Third Edition, 2012.

John G. Proakis and MasoudSalehi, "Fundamentals of Communication Systems", Pearson Education, Second Edition, 2013.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.

### Course Objectives

- Gain in-depth understanding of the fundamental networking principles, the challenges involved and implementation issues encountered in designing practical network protocols at Internet scale
- Analyze both qualitatively and quantitatively the performance of network protocols and system architectural design choices
- Connect networking principles with the actual implementation details as found in networking standards currently used in practice
- Gain hands-on experience by watching the protocols in action through simulation and/or software/hardware experiments

### Course Outcomes

**CO1:** Able to understand the fundamental networking principles and protocol concepts

**CO2:** Able to connect networking principles with the practical network protocols currently used in the Internet

**CO3:** Able to analyze the performance of network protocols and system architectural design choice.

**CO4:** Able to simulate, implement and monitor the performance of standard networking protocols by a network simulator, socket programming and a packet sniffer, respectively

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | -   | 3   | 3   | -   | -   | -   | -   | -   | 3    | -    | 3    | 3    | 3    |
| CO2    | 3   | 3   | 3   | 3   | 3   | -   | -   | -   | -   | 3    | -    | 3    | 3    | 3    |
| CO3    | 3   | 3   | 3   | 3   | 3   | -   | -   | -   | -   | 3    | -    | 3    | 3    | 3    |
| CO4    | -   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | -   | 3    | -    | 3    | 3    | 3    |

### Syllabus

#### Unit 1

Introduction to the Internet - Services and Protocols - Edge and Core - Packet Switching vs. Circuit Switching - Performance Metrics Delay – Loss – Throughput - Protocol Layers and Service Models OSI and TCP/IP models - Application Layer - Client-Server and Peer-to-Peer architectures - Application Layer protocols - Transport Layer -Unreliable Connectionless vs. Reliable Connection- Oriented Services – Multiplexing - Stop-and-Wait - Go-Back-N and Selective-Repeat - UDP vs. TCP - Flow and Congestion Control.

#### Unit 2

Network Layer - Data plane forwarding vs. Control plane routing - Software Defined Networking (SDN) approach - Network Services - Router architecture - Switching fabrics - Input and output queueing - IPv4 and IPv6 addressing DHCP – NAT - IPv4 and IPv6 fragmentation - SDN based generalized forwarding - Routing an Supporting Algorithms - Link State vs. Distance Vector – RIP – OSPF – BGP – ICMP – SNMP - SDN Control Plane.

#### Unit 3

Link Layer – Services - Error Detection and Correction - Multiple Access protocols Channel partitioning - Random access - Taking-Turns protocols - Switched LANs ARP – Ethernet - Link layer switching – VLANs – MPLS - Introduction to Wireless and Mobile Networks - Link characteristics – CDMA - 802.11 WiFi - Bluetooth and Zigbee - Cellular Networks – GSM – UMTS – LTE - Mobility management and handoff - Mobile IP.

**Lab component**

Socket Programming using Python 3 - Client-Server Application using TCP and UDP services - Building a web server - a HTTP client - an email client - a Ping protocol - Shortest Path Algorithms using Python -Simulation of wireless local - personal and wide area networks using NS2 - Analysis of trace files and inferencing -Building your own protocol in NS2 - Network Health Monitoring using Wireshark packet sniffer.

**Text book(s)**

James Kurose and Keith Ross, "Computer Networking: A Top-Down Approach", Seventh (Global) Edition, Pearson Education Ltd., 2017.

Larry L. Peterson and Bruce S. Davie, "Computer Networks - A Systems Approach", Morgan Kaufmann, Fifth Edition, 2011.

**Reference(s)**

Brandon Rhodes, John Goerzen, "Foundations of Python Network Programming", Third Edition, Apress, 2014.

Teerawat Issariyakul and Ekram Hossain, "Introduction to Network Simulator NS2", Springer, Boston, MA, 2009.

**Evaluation Pattern**

| Assessment                            | Internal | External |
|---------------------------------------|----------|----------|
| Periodical 1                          | 10       |          |
| Periodical 2                          | 10       |          |
| *Continuous Assessment (Theory) (CAT) | 15       |          |
| Continuous Assessment (Lab) (CAL)     | 30       |          |
| End Semester                          |          | 35       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Digital Design

### Course Objectives

- To introduce the basic organization of a computer system
- To learn the functioning of data path and control path elements in a processor
- To understand the memory organization of a processor system
- To understand the input-output operations in a processor system

### Course Outcomes

**CO1:** Able to comprehend operations and arithmetic of computer systems

**CO2:** Able to identify data-path and control-path operations involved in the execution of a processor instruction

**CO3:** Able to understand and analyze the CPU, memory and IO architecture of a processor at the system level

**CO4:** Able to analyze the trade-offs involved in the CPU and memory organization of a processor system

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | -   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |
| CO2    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |
| CO3    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |
| CO4    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |

### Syllabus

#### Unit 1

Introduction to computer system - Brief history of computer systems - Fixed point arithmetic – Addition – Subtraction - Multiplication and division - Booth's algorithm - Non-restoring division algorithm - Floating point arithmetic - Various addressing modes and designing of an Instruction set.

#### Unit 2

Data path and controller design - Introduction to CPU design - Processor organization - Execution of complete Instruction - Design of control unit - Hardwired Control – Microprogrammed Control.

#### Unit 3

Memory and system organization - Concepts of semiconductor memory - CPU-memory interaction - Organization of memory modules - Cache memory and related mapping and replacement policies - Virtual memory - Input/output

Processing - Introduction to Interrupts and DMA - Introduction to RISC and CISC approaches.

#### Text book(s)

*V. Carl Hamacher, Zvonko G. Varanescic and Safat G. Zaky, "Computer Organisation", Fifth edition, Indian Edition, McGraw-Hill Education, 2011.*

*John P. Hayes, "Computer architecture and Organisation", Indian Edition, McGraw-Hill Education, 2017.*

#### Reference(s)

*M. Morris Mano, "Computer System Architecture", Third Edition, Pearson Education, 2007.*

*Behrooz Parhami, "Computer Architecture", Indian Edition, Oxford University Press, 2012.*

### Evaluation Pattern

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Nil

**Course Objectives**

- To develop skill in collection and review the literature in selected technology domain
- To comprehend the literature and derive conclusion
- To develop technical presentation skills

**Course Outcomes**

**CO1:** Ability to understand and analyze the literature

**CO2:** Ability to understand design aspect and analyze solutions to engineering problems

**CO3:** Ability to qualitatively evaluate the solutions on sustainable and ethical aspects

**CO4:** Ability to conduct collaborative discussions and presentations

**CO-PO Mapping**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|-------|-------|
| CO1   | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 3    | 3     | 2     |
| CO2   | -   | -   | 3   | 3   | -   | 3   | -   | -   | -   | -    | -    | 3    | 3     | 2     |
| CO3   | -   | -   | -   | -   | -   | 3   | 3   | 3   | -   | -    | -    | 3    | 3     | 2     |
| CO4   | -   | -   | -   | -   | -   | -   | -   | -   | 3   | 3    | -    | 3    | 3     | 2     |

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| *Continuous Assessment (CA) | 80       |          |
| End Semester                |          | 20       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports



**Pre Requisite(s):** Nil

### Course Objectives

- To implement Hardware Prototype for a Smart Device
- To Develop basic programming skills for deploying various IoT protocols in hardware
- To Design and Develop Internet of Things based solutions for Home Automation

### Course Outcomes

**CO1:** Able to interface basic digital and Analog Sensors using Raspberry Pi

**CO2:** Able to analyze various IoT Protocols used in the field of Smart Devices

**CO3:** Able to implement various Machine Learning Techniques using Raspberry Pi

**CO4:** Able to design and develop portable Image Processing system using Raspberry Pi

### CO-PO Mapping

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1   | 3   | -   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO2   | 3   | 2   | 3   | -   | 2   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO3   | 3   | -   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO4   | 3   | 3   | 3   | 3   | 2   | 2   | -   | -   | -   | -    | -    | -    | 3    | 2    |

### Syllabus

1. Introduction to Raspberry Pi and Porting OS.
2. Python based basic programs using Raspberry Pi.
3. GPIO and associated peripheral interfacing.
4. Interfacing Analog peripherals.
5. Creation of Web server and its interaction using SSH.
6. Publishing Data using HTTP.
7. Sensor Interfacing and Logging using MQTT.
8. Basic Machine Learning using Raspberry Pi.
9. Introducing basic Image processing Techniques.
10. Interfacing onboard camera with Raspberry Pi.

### Text book(s)

Peter Waher, "Mastering Internet of Things: Design and create your own IoT applications using Raspberry Pi 3", First Edition, Packt Publishing, 2018.

### Reference(s)

John C. Shovic, "Raspberry Pi IoT Projects: Prototyping Experiments for Makers", Packt Publishing, 2016.

### Evaluation Pattern

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| *Continuous Assessment (CA) | 80       |          |
| End Semester                |          | 20       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):**Communication Theory

### Course Objectives

- To gain hands-on experience of analog and digital modulation and demodulation methods by seeing the hardware implementation and/or computer simulation of the methods in action
- To acquire the skill of troubleshooting the hardware realization and debugging the computer simulation code of modulation and demodulation methods
- To conduct communication experiments in an organized manner by thorough pre-experiment preparation including gaining the knowledge about the hardware components and/or software functions

### Course Outcomes

**CO1:** Able to implement modulation and demodulation methods in hardware and troubleshoot

**CO2:** Able to simulate modulation and demodulation methods in computer and analyze the performance

**CO3:** Able to understand the strengths and limitations of the hardware components and computer simulations

**CO4:** Able to organize communication experiments and present the outcomes in an effective manner

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -    | -    | 3    | 3    | 3    |
| CO2    | 3   | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -    | -    | 3    | 3    | 3    |
| CO3    | 3   | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -    | -    | 3    | 3    | 3    |
| CO4    | -   | -   | -   | -   | -   | -   | -   | -   | 3   | 3    | -    | 3    | -    | -    |

### Syllabus

1. Amplitude Modulation.
2. Frequency Modulation.
3. Time Division Multiplexing.
4. Pulse Amplitude Modulation.
5. Amplitude Shift Keying.
6. Phase Shift Keying.
7. Frequency Shift Keying.
8. Eye Pattern Generation.
9. Digital Pulse Modulation Schemes(computer experiment).
10. Gram Schmidt orthogonalization (computer experiment).
11. Probability of Error Calculation (computer experiment).

### Text book(s)

John G. Proakis and MasoudSalehi, “Digital Communications”, McGraw-Hill Higher Education, Fifth Edition, 2008.

Simon Haykin, “Digital Communication Systems”, John Wiley & Sons, 2014.

**Reference(s)**

*John G. Proakis, MasoudSalehi and Gerhard Bauch, "Contemporary Communication Systems Using MATLAB", Cengage Learning India, Third Edition, 2012.*

*John G. Proakis and MasoudSalehi, "Fundamentals of Communication Systems", Pearson Education, Second Edition, 2013.*

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| *Continuous Assessment (CA) | 80       |          |
| End Semester                |          | 20       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

### Course Outcomes

**CO # 1 - Soft Skills:** At the end of the course, the students will have the ability to communicate convincingly and negotiate diplomatically while working in a team to arrive at a win-win situation. They would further develop their inter-personal and leadership skills.

**CO # 2 - Soft Skills:** At the end of the course, the students shall learn to examine the context of a Group Discussion topic and develop new perspectives and ideas through brainstorming and arrive at a consensus.

**CO # 3 - Aptitude:** At the end of the course, students will be able to identify, recall and arrive at appropriate strategies to solve questions on geometry. They will be able to investigate, interpret and select suitable methods to solve questions on arithmetic, probability and combinatorics.

**CO # 4 – Verbal:** At the end of the course, the students will have the ability to relate, choose, conclude and determine the usage of right vocabulary.

**CO # 5 - Verbal:** At the end of the course, the students will have the ability to utilise prior knowledge of grammar to recognise structural instabilities and modify them.

**CO # 6 – Verbal** At the end of the course, the students will have the ability to comprehend, interpret, deduce and logically categorise words, phrases and sentences. They will also have the ability to theorise, discuss, elaborate, criticise and defend their ideas.

### Syllabus

Professional grooming and practices: Basics of corporate culture, key pillars of business etiquette. Basics of etiquette: Etiquette – socially acceptable ways of behaviour, personal hygiene, professional attire, cultural adaptability. Introductions and greetings: Rules of the handshake, earning respect, business manners. Telephone etiquette: activities during the conversation, conclude the call, to take a message. Body Language: Components, undesirable body language, desirable body language. Adapting to corporate life: Dealing with people.

Group discussions: Advantages of group discussions, structured GD – roles, negative roles to be avoided, personality traits to do well in a GD, initiation techniques, how to perform in a group discussion, summarization techniques.

Listening comprehension advanced: Exercise on improving listening skills, grammar basics: Topics like clauses, punctuation, capitalization, number agreement, pronouns, tenses etc.

Reading comprehension advanced: A course on how to approach middle level reading comprehension passages.

Problem solving level III: Money related problems; Mixtures; Symbol based problems; Clocks and calendars; Simple, linear, quadratic and polynomial equations; special equations; Inequalities; Functions and graphs; Sequence and series; Set theory; Permutations and combinations; Probability; Statistics.

Data sufficiency: Concepts and problem solving.

Non-verbal reasoning and simple engineering aptitude: Mirror image; Water image; Paper folding; Paper cutting; Grouping of figures; Figure formation and analysis; Completion of incomplete pattern; Figure matrix; Miscellaneous.

Spacial aptitude: Cloth, leather, 2D and 3D objects, coin, match sticks, stubs, chalk, chess board, land and geodesic problems etc., related problems.

#### TEXTBOOK(S)

*A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.*

*Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.*

*Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.*

*The Hard Truth about Soft Skills, by Amazone Publication.*

*Quick Maths – Tyra.*

*Quicker Arithmetic – Ashish Aggarwal*

*Test of reasoning for competitive examinations by Thorpe.E. TMH*

*Non-verbal reasoning by R. S. Aggarwal, S. Chand*

**REFERENCE(S)**

*Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova More Games Teams Play, by Leslie Bendaly, McGraw Hill Ryerson.*

*The BBC and British Council online resources*

*Owl Purdue University online teaching resources*

*www.the grammarbook.com - online teaching resources www.englishpage.com- online teaching resources and other useful websites.*



### Course Objectives

- Identify and analyse the various challenge indicators present in the village by applying concepts of Human Centered Design and Participatory Rural Appraisal.
- User Need Assessment through Quantitative and Qualitative Measurements
- Designing a solution by integrating Human Centered Design concepts
- Devising proposed intervention strategies for Sustainable Social Change Management

### Course Outcome

**CO1:** Learn ethnographic research and utilise the methodologies to enhance participatory engagement.

**CO2:** Prioritize challenges and derive constraints using Participatory Rural Appraisal.

**CO3:** Identify and formulate the research challenges in rural communities.

**CO4:** Design solutions using human centred approach.

### CO-PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |
| CO1    |     | 3   |     | 3   |     | 1   | 1   |     | 3   | 3    |      | 3    |
| CO2    |     | 3   |     |     |     |     |     | 3   | 3   | 3    |      |      |
| CO3    |     | 3   |     |     |     |     | 1   |     | 3   | 3    |      | 3    |
| CO4    | 3   |     | 3   |     |     |     | 3   | 3   | 3   | 3    |      | 3    |

### Syllabus

This initiative is to provide opportunities for students to get involved in coming up with technology solutions for societal problems. The students shall visit villages or rural sites during the vacations (after 4th semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth semester.

#### Thematic Areas

- Agriculture & Risk Management
- Education & Gender Equality
- Energy & Environment
- Livelihood & Skill Development
- Water & Sanitation
- Health & Hygiene
- Waste Management & Infrastructure

The objectives and the projected outcome of the project will be reviewed and approved by the department chairperson and a faculty assigned as the project guide.

### Evaluation Pattern

| Assessment  | Marks      |
|---|------------|
| <b>Internal (Continuous Evaluation) [75 marks]</b>      |            |
| Workshop (Group Participation)                          | 15         |
| Village Visit Assignments & Reports                     | 15         |
| Problem Identification and Assessment                   | 15         |
| Ideation: Defining the Needs, Proposed Designs & Review | 20         |
| Poster Presentation                                     | 10         |
| <b>External [25 marks]</b>                              |            |
| Research Paper Submission                               | 25         |
| <b>Total</b>  | <b>100</b> |
| Attendance (To be added separately)                     | 5          |
| <b>Grand Total</b>                                      | <b>105</b> |



**Pre Requisite(s):** Digital Communication

### Course Objectives

- To introduce the physical layer characteristics of wireless communication systems
- To impart insights of fading channel parameter evaluation and study of statistical channel models
- To facilitate the importance of signal processing techniques to mitigate the channel impairments

### Course Outcomes

**CO1:** Able to understand the physical medium characteristics for the analysis of wireless communication systems

**CO2:** Able to identify the fading channel parameters to propose design solutions for terrestrial wireless systems

**CO3:** Able to conduct investigations and provide valid conclusions in the field of communication

**CO4:** Able to apply the contextual knowledge in design - development of solutions of complex engineering problems

**CO5:** Able to learn the emerging wireless communication standards

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO2    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | 2    |
| CO3    | -   | 3   | 3   | 3   | -   | -   | 3   | -   | -   | -    | -    | -    | 2    | -    |
| CO4    | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO5    | 3   | -   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 3    | -    | -    |

### Syllabus

#### Unit 1

Introduction to wireless communications - Large scale path loss - Free space propagation model - Two ray model – Practical link budget design – Outdoor and indoor propagation models. Small scale multi path propagation – Impulse response model of a multi path channel - Parameters of mobile multi path channels - Types of small scale Fading.

#### Unit 2

Rayleigh and Rician distributions – Statistical models for multipath fading channels – Theory of multipath shaping factors - Equalization - Linear - Decision feedback - Adaptive equalizers - Training and tracking. Diversity – Receiver diversity – Transmitter diversity.

#### Unit 3

Capacity of wireless channels – Capacity in AWGN – Flat fading channels – Frequency selective channels – Time invariant and variant channels - Performance of digital modulations over wireless channels – AWGN and Fading channels.

#### Text book(s)

*Andrea Goldsmith, "Wireless Communication", Cambridge University Press, 2005.*

*T.S. Rappaport, "Wireless Communication, Principles and Practice", Pearson Education, Second Edition, 2002.*

**Reference(s)**

*William C Y Lee, "Wireless and Cellular Communications", Tata McGraw Hill Publishing Company Limited, Third Edition, 2006.*

*Robert W. Heath Jr., "Introduction to Wireless Digital Communication: A Signal Processing Perspective", Prentice Hall, First Edition, 2017.*

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

### Course Objectives

- To mould fresh electronics engineers by enhancing their knowledge and skills in various hardware and software design aspects of Cyber Physical Systems
- To develop an exposition of the challenges in implementing a cyber-physical system from a computational perspective
- To expose the student to real world problems in this domain and provide a walk through the design and validation problems for such systems

### Course Outcomes

**CO1:**Able to understand the various platform aspects of cyber physical systems

**CO2:**Able to understand various modeling formalisms for CPS, such as hybrid automata & state-space methods

**CO3:**Able to understand and analyse CPS security and safety aspects

**CO4:**Able to understand the basics of CPS implementation and design

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 3   | 2   | 2   | -   | 2   | 2   | -   | 2   | 2    | -    | 2    | 3    | 2    |
| CO2    | 3   | 3   | 2   | 2   | 3   | -   | -   | -   | 2   | 2    | -    | 2    | 3    | 2    |
| CO3    | 3   | 3   | 2   | 2   | 3   | 2   | 2   | -   | 2   | 2    | -    | 2    | 3    | 2    |
| CO4    | 3   | 3   | 2   | 2   | 3   | -   | -   | 2   | 2   | 2    | -    | 2    | 3    | 2    |

### Syllabus

#### Unit 1

Cyber-Physical Systems Overview - Cyber-Physical Systems (CPS) in the real world - Basic principles of design and validation of CPS - Industry 4.0, AutoSAR, IIOT implications - Building Automation, Medical CPS. CPS – Platform- CPS HW platforms - Processors, Sensors, Actuators - CPS Network - Wireless Hart, CAN, Automotive Ethernet- CPS Sw stack – RTOS - Scheduling Real Time control tasks.

#### Unit 2

Principles of Automated Control Design - Dynamical Systems and Stability - Controller Design Techniques - Stability Analysis: CLFs, MLFs, stability under slow switching - Performance under Packet drop and Noise. CPS implementation issues - From features to automotive software components, Mapping software components to ECUs - CPS Performance Analysis - effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion - Building real-time networks for CPS.

#### Unit 3:

Intelligent CPS - Safe Reinforcement Learning - Robot motion control - Autonomous Vehicle control - Gaussian Process Learning - Smart Grid Demand Response - Building Automation. Secure Deployment of CPS -Secure Task mapping and Partitioning - State estimation for attack detection - Automotive Case study : Vehicle ABS hacking - Power Distribution Case study : Attacks on Smart Grids.

**Lab Component:** Experiments based on Ptolemy and CPS platforms.

**Text Book(s)**

Rajeev Alur "Principles of Cyber-Physical Systems", MIT Press, 2015.

E. A. Lee, SanjitSeshia "Introduction to Embedded Systems – A Cyber–Physical Systems Approach", MIT Press, 2013.

**Evaluation Pattern**

| Assessment                            | Internal | External |
|---------------------------------------|----------|----------|
| Periodical 1                          | 10       |          |
| Periodical 2                          | 10       |          |
| *Continuous Assessment (Theory) (CAT) | 15       |          |
| Continuous Assessment (Lab) (CAL)     | 30       |          |
| End Semester                          |          | 35       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.

**Pre Requisite(s):** Computational Electromagnetics

### Course Objectives

- To understand the principle of operation of radio frequency devices and circuits
- To study the device performance using scattering parameters
- To understand the concepts of wireless communication systems
- To expose the RF technologies used in various applications

### Course Outcomes

**CO1:** Able to understand basic mathematical tools required for analyzing RF systems

**CO2:** Able to design planar devices and analyze their performance

**CO3:** Able to comprehend system level parameters in RF systems

**CO4:** Able to apply RF design concepts to Wireless technologies

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 2   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO2    | 3   | 2   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO3    | 3   | 2   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | 2    |
| CO4    | 3   | 2   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | 2    |

### Syllabus

#### Unit 1

Electromagnetic frequency spectrum with applications – network parameters – scattering matrix – S-parameter analysis of passive waveguide devices – power dividers – combiners - phase shifters – Rectangular waveguide resonators.

#### Unit 2

Planar passive devices – microstrip lines – striplines – transmission line resonators – T-junction power dividers – quarter-wave transformers – Noise in RF systems – Noise figure computations – non linear distortion – Dynamic range.

#### Unit 3

RF Communication systems – Friss formula – link budget – antenna noise temperature – carrier to noise ratio – antenna parameters – bit error rate calculations – Case studies on direct broadcasting systems – global positioning systems – WLAN – Spectrum regulations and standards.

#### Text Book(s)

David M. Pozar, "Microwave Engineering", Wiley India Limited, Fourth Edition, 2012.

Samuel. Y. Liao, "Microwave Devices and Circuits", Pearson Education, Third Edition, 2004.

#### Reference(s)

Ludwig R, Bogdanov G, RF Circuit Design, Theory and Applications, Pearson Education Inc, Second Edition, 2013.

### Evaluation Pattern

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.

**Pre Requisite(s):** Computational Electromagnetics

### Course Objectives

- To get hands on experience in building the RF circuits and analyze its performance
- To practice the tools used for simulations and its parameters and syntax in the circuit design
- To become the expertise in RF design and performance analysis

### Course Outcomes

**CO1:** Ability to understand the concepts of RF signal transmission through waveguides

**CO2:** Ability to analyze the scattering parameters of RF devices

**CO3:** Ability to apply the RF design concepts and characterize using simulation tools

**CO4:** Ability to design and analyze RF circuits using simulation tools

### CO/PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -    | -    | 3    | 3    | 3    |
| CO2    | 3   | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -    | -    | 3    | 3    | 3    |
| CO3    | 3   | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -    | -    | 3    | 3    | 3    |
| CO4    | -   | 2   | -   | -   | -   | -   | -   | -   | 3   | 3    | -    | 3    | -    | -    |

### Syllabus

1. Characterization of waveguide based microwave setup.
2. Measurement of radiation pattern of horn antennas.
3. Measurement of return loss and insertion loss of any selected microwave component.
4. Characterization of materials using two-antenna method.
5. Electromagnetic simulation and scattering parameters study on microstrip lines.
6. Electromagnetic simulation and characterization of rectangular microstrip antenna.
7. Electromagnetic simulation and characterization of circular microstrip antenna.
8. Electromagnetic simulation and characterization of microstrip power dividers.
9. Electromagnetic simulation and characterization of rectangular microstrip resonator.
10. Electromagnetic simulation and characterization of hybrid ring couplers.

### Text book(s)

David M. Pozar, "Microwave Engineering", Wiley India Limited, Fourth Edition, 2012.

### Reference(s)

Samuel. Y. Liao, "Microwave Devices and Circuits", Pearson Education, Third Edition, 2004.

### Evaluation Pattern

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| *Continuous Assessment (CA) | 80       |          |
| End Semester                |          | 20       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Nil

### Course Objectives

- To provide platform for creative and innovative thinking
- To develop competency in design, development and analysis of solutions to real time problems
- To enable hardware prototyping of solutions to effectively transform ideas to reality

### Course Outcomes

**CO1:** Ability to analyze practical problems and investigate scope for applying technology to develop feasible solutions

**CO2:** Ability to review the state of the art literature in the selected technology domain and arrive functional solutions

**CO3:** Design the required system using appropriate EDA tools and implement the hardware

**CO4:** Ability to analyze the implementation impact and suggest improvements or modifications

**CO5:** Present the concept with adequate validation on technical aspects and cost analysis using a report and seminar

### CO-PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | -   | -   | -   | -   | 2   | -   | -   | 2   | -    | -    | 2    | 3    | -    |
| CO2    | -   | 3   | -   | -   | -   | -   | 2   | -   | 2   | -    | -    | 2    | 3    | -    |
| CO3    | -   | -   | 3   |     | 2   | -   | -   | 2   | -   | -    | -    | -    | 3    | 2    |
| CO4    | -   | -   | -   | 3   | 2   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO5    | -   | -   | -   | -   | -   | -   | -   | 2   | 2   | 3    | 2    | -    | -    | -    |

### Evaluation Pattern

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| *Continuous Assessment (CA) | 80       |          |
| End Semester                |          | 20       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports



**Course Outcomes:**

**CO # 1 - Soft Skills:** At the end of the course, the students will have the ability to prepare a suitable resume (including video resume). They would also have acquired the necessary skills, abilities and knowledge to present themselves confidently. They would be sure-footed in introducing themselves and facing interviews.

**CO # 2 - Soft Skills:** At the end of the course, the students will have the ability to analyse every question asked by the interviewer, compose correct responses and respond in the right manner to justify and convince the interviewer of one's right candidature through displaying etiquette, positive attitude and courteous communication.

**CO # 3 - Aptitude:** At the end of the course, students will be able to interpret, critically analyze and solve logical reasoning questions. They will have acquired the skills to manage time while applying methods to solve questions on arithmetic, algebra, logical reasoning, and statistics and data analysis and arrive at appropriate conclusions.

**CO # 4 – Verbal:** At the end of the course, the students will have the ability to understand and use words, idioms and phrases, interpret the meaning of standard expressions and compose sentences using the same.

**CO # 5 - Verbal:** At the end of the course, the students will have the ability to decide, conclude, identify and choose the right grammatical construction.

**CO # 6 – Verbal:** At the end of the course, the students will have the ability to examine, interpret and investigate arguments, use inductive and deductive reasoning to support, defend, prove or disprove them. They will also have the ability to create, generate and relate facts / ideas / opinions and share / express the same convincingly to the audience / recipient using their communication skills in English.

Team work: Value of team work in organisations, definition of a team, why team, elements of leadership, disadvantages of a team, stages of team formation. Group development activities: Orientation, internal problem solving, growth and productivity, evaluation and control. Effective team building: Basics of team building, teamwork parameters, roles, empowerment, communication, effective team working, team effectiveness criteria, common characteristics of effective teams, factors affecting team effectiveness, personal characteristics of members, team structure, team process, team outcomes.

Facing an interview: Foundation in core subject, industry orientation / knowledge about the company, professional personality, communication skills, activities before interview, upon entering interview room, during the interview and at the end. Mock interviews.

Advanced grammar: Topics like parallel construction, dangling modifiers, active and passive voices, etc.

Syllogisms, critical reasoning: A course on verbal reasoning. Listening comprehension advanced: An exercise on improving listening skills.

Reading comprehension advanced: A course on how to approach advanced level of reading, comprehension passages. Exercises on competitive exam questions.

Problem solving level IV: Geometry; Trigonometry; Heights and distances; Co-ordinate geometry; Mensuration.

Specific training: Solving campus recruitment papers, national level and state level competitive examination papers; Speed mathematics; Tackling aptitude problems asked in interview; Techniques to remember (In mathematics). Lateral thinking problems. Quick checking of answers techniques; Techniques on elimination of options, estimating and predicting correct answer; Time management in aptitude tests; Test taking strategies.

**TEXTBOOK(S)**

*A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.*

*Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.*

*Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.*

*The Hard Truth about Soft Skills, by Amazone Publication.*

*Data Interpretation by R. S. Aggarwal, S. Chand*

*Logical Reasoning and Data Interpretation – Niskit K Sinkha*

*Puzzles – Shakuntala Devi*

*Puzzles – George J. Summers.*

## **REFERENCE(S)**

*Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova.*

*More Games Teams Play, by Leslie Bendaly, McGraw-Hill Ryerson.*

*The BBC and British Council online resources*

*Owl Purdue University online teaching resources*

*www.the grammarbook.com - online teaching resources www.englishpage.com- online teaching resources and other useful websites.*

### Course Objectives

- Proposal writing in order to bring in a detailed project planning, enlist the materials required and propose budget requirement.
- Use the concept of Co Design to ensure User Participation in the Design Process in order to rightly capture user needs/requirements.
- Building and testing a prototype to ensure that the final design implementation is satisfies the user needs, feasible, affordable, sustainable and efficient.
- Real time project implementation in the village followed by awareness generation and skill training of the users (villagers)

### Course Outcome

**CO1:** Learn co-design methodologies and engage participatorily to finalise a solution

**CO2:** Understand sustainable social change models and identify change agents in a community.

**CO3:** Learn Project Management to effectively manage the resources

**CO4:** Lab scale implementation and validation

**CO5:** Prototype implementation of the solution

### CO-PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |
| CO1    | 1   | 1   | 3   | 3   |     |     | 1   | 3   | 3   | 3    |      | 3    |
| CO2    |     |     |     |     |     |     |     |     | 3   | 3    |      |      |
| CO3    |     |     |     |     |     |     |     |     | 3   | 3    | 3    |      |
| CO4    | 3   |     | 3   |     |     | 3   | 1   | 3   | 3   | 3    |      | 3    |
| CO5    |     |     | 1   |     |     |     |     |     | 3   | 3    |      |      |

### Syllabus

The students shall visit villages or rural sites during the vacations (after 6th semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth semester.

#### Thematic Areas

- Agriculture & Risk Management
- Education & Gender Equality
- Energy & Environment
- Livelihood & Skill Development
- Water & Sanitation
- Health & Hygiene
- Waste Management & Infrastructure

## Evaluation Pattern

| Assessment  | Marks      |
|---|------------|
| <b>Internal (Continuous Evaluation) [63 marks]</b>    |            |
| 1. Proposed Implementation                            | <b>2</b>   |
| Presentation Round 1                                  |            |
| 2. Proposal Submission + Review                       | <b>6</b>   |
| 3. Co-design  | <b>6</b>   |
| i. Village Visit I (Co-Design Field Work Assignments) | 4          |
| ii. Presentation of Co-design Assessment              | 2          |
| 4. Prototype Design                                   | <b>14</b>  |
| i. Prototype Design                                   | 4          |
| ii. Prototype Submission                              | 8          |
| iii. Sustenance Plan                                  | 2          |
| 5. Implementation                                     | <b>35</b>  |
| i. Implementation Plan Review                         | 3          |
| ii. Implementation                                    | 24         |
| iii. Testing & Evaluation                             | 4          |
| iv. Sustenance Model Implementation                   | 4          |
| <b>External [37 marks]</b>                            |            |
| 6. Research Paper                                     | <b>18</b>  |
| 7. Final Report                                       | <b>15</b>  |
| 8. Poster Presentation                                | <b>4</b>   |
| <b>Total</b>  | <b>100</b> |
| Attendance  | 5          |
| <b>Grand Total</b>                                    | <b>10</b>  |

**Course Objectives**

To provide an awareness on the types and impacts of disasters and concepts of disaster management

**Course Outcome**

**CO 1:** Analyze relationship between Development and Disasters.

**CO 2:** Understand impact of Disasters and realization of societal responsibilities

**CO 3:** Apply Disaster management principles

**CO-PO Mapping**

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |      |
| CO1    | 2   | 3   |     |     |     | 2   | 3   | 2   |     | 3    |      | 2    |      |      | 3    |
| CO2    | 2   | 3   |     |     |     | 2   | 3   | 2   | 2   | 2    |      | 2    |      |      | 3    |
| CO3    | 2   | 3   |     |     |     | 2   |     | 2   |     |      |      | 2    |      |      | 3    |

**Syllabus****Unit 1**

Introduction - Concepts and definitions. Disasters - Disasters classification; natural disasters (floods, draught, cyclones, volcanoes, earthquakes, tsunamis, landslides, coastal erosion, soil erosion, forest fires etc.); man-made disasters (industrial pollution, artificial flooding in urban areas, nuclear radiation, chemical spills, transportation accidents, terrorist strikes, etc.)

**Unit 2**

Hazard and vulnerability profile of India, mountain and coastal areas, ecological fragility. Factors affecting vulnerability such as impact of developmental projects and environmental modifications (including of dams, land use changes, urbanization etc.)

Disaster Impacts - Disaster impacts (environmental, physical, social, ecological, economic, political, etc.); health, psycho-social issues; demographic aspects (gender, age, special needs); hazard locations; global and national disaster trends; climate change and urban disasters.

**Unit 3**

Disaster Risk Reduction (DRR) - Disaster management cycle – its phases; prevention, mitigation, preparedness, relief and recovery; structural and non-structural measures; risk analysis, vulnerability and capacity assessment; early warning systems, Post disaster environmental response (water, sanitation, food safety, waste management, disease control, security, communications); Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR programmes in India and the activities of National Disaster Management Authority.

**Text Book(s)**

*R. Subramanian, Disaster Management, Vikas Publishing House (2018)*

**Reference(s)**

*Bhandari and Rajendra Kumar, Disaster Education and Management, Springer, 2016.*

*NIDM publications, <https://nidm.gov.in/books.asp>*

*<http://ndma.gov.in/> (Home page of National Disaster Management Authority)*

*<http://www.ndmindia.nic.in/> (National Disaster management in India, Ministry of Home Affairs).*

*Pradeep Sahni, 2004, Disaster Risk Reduction in South Asia, Prentice Hall.*  
*Singh B.K., 2008, Handbook of Disaster Management: Techniques & Guidelines, Rajat Publication.*  
*Ghosh G.K., 2006, Disaster Management, APH Publishing Corporation*  
*Inter Agency Standing Committee (IASC) (Feb. 2007). IASC Guidelines on Mental Health and Psychosocial Support in Emergency Settings. Geneva: IASC*

### **Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| *Continuous Assessment (CA) | 80       |          |
| **End Semester              |          | 20       |

•CA – Can be Discussions/Debates/Quiz/ Case study presentation

\*\* - Term project

## SEMESTER VII

19CCE495

PROJECT PHASE I

L-T-P-C: 0-0-6-2

**Pre Requisite(s):** Nil

### Course Objectives

- To define the problem of the proposed research work
- To apply the concepts of electronics engineering design in solving the research problem
- To demonstrate and validate the results of the design concept

### Course Outcomes

**CO1:** Able to identify and formulate research problem

**CO2:** Able to design and develop solution to the problem

**CO3:** Able to analyze and solve the complex problems

**CO4:** Able to plan, implement and execute the project

**CO5:** Able to write effective technical report and demonstrate through presentation

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 3   | -   | -   | -   | 3   | 3   | -   | 3   | -    | -    | -    | 3    | 3    |
| CO2    | 3   | 3   | 3   | -   | 2   | -   | -   | 3   | 3   | -    | -    | 3    | 3    | 3    |
| CO3    | -   | -   | 3   | 3   | 3   | 2   | 2   | 3   | 3   | -    | -    | 3    | 3    | 3    |
| CO4    | -   | -   | -   | -   | 3   | 2   | 3   | 3   | 3   | 3    | 3    | 3    | 3    | 2    |
| CO5    | -   | -   | -   | -   | -   | -   | -   | 2   | 3   | 3    | -    | 3    | -    | -    |

### Evaluation Pattern

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| *Continuous Assessment (CA) | 60       |          |
| End Semester                |          | 40       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.

## SEMESTER VIII

**19CCE499**

**PROJECT PHASE II**

**L-T-P-C: 0-0-30-10**

**Pre Requisite(s):** Nil

### Course Objectives

- To define the problem of the proposed research work
- To apply the concepts of electronics engineering design in solving the research problem
- To demonstrate and validate the results of the design concept

### Course Outcomes

**CO1:** Able to identify and formulate research problem

**CO2:** Able to design and develop solution to the problem

**CO3:** Able to analyze and solve the complex problems

**CO4:** Able to plan, implement and execute the project

**CO5:** Able to write effective technical report and demonstrate through presentation

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 3   | -   | -   | -   | 3   | 3   | -   | 3   | -    | -    | -    | 3    | 3    |
| CO2    | 3   | 3   | 3   | -   | 2   | -   | -   | 3   | 3   | -    | -    | 3    | 3    | 3    |
| CO3    | -   | -   | 3   | 3   | 3   | 2   | 2   | 3   | 3   | -    | -    | 3    | 3    | 3    |
| CO4    | -   | -   | -   | -   | 3   | 2   | 3   | 3   | 3   | 3    | 3    | 3    | 3    | 2    |
| CO5    | -   | -   | -   | -   | -   | -   | -   | 2   | 3   | 3    | -    | 3    | -    | -    |

### Evaluation Pattern

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| *Continuous Assessment (CA) | 60       |          |
| End Semester                |          | 40       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.



## PROFESSIONAL ELECTIVES

### Computational Engineering

19CCE331

MARKOV PROCESS AND QUEUING TH.

L-T-P-C: 3-0-0-3

**Pre Requisite(s):** Probability and Random Processes

#### Course Objectives

- To provide a thorough understanding of the mathematical foundations of telecommunication and computer communication networks
- To teach the application of Markov processes and queueing theory to analyze the performance of and address the design questions in circuit- and packet-switching networks
- To gain hands-on experience of discrete-event simulations of queueing systems

#### Course Outcomes

**CO1:** Able to map frequently occurring scenarios in telecommunication and computer networking into standard stochastic models, i.e., able to construct mathematical models from the physical description of the problems

**CO2:** Able to identify appropriate solution methods and physically interpret themathematical results

**CO3:** Able to analyze and compare the performance of queueing systems by discrete-event simulations

**CO4:** Gain professional knowledge and skills by term projects

#### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -   | 3    | -    | 3    | 3    | 3    |
| CO2    | 3   | 3   | 3   | 3   | 3   | -   | -   | -   | -   | 3    | 2    | 3    | 3    | 3    |
| CO3    | 3   | 3   | 3   | 3   | 3   | -   | -   | -   | -   | 3    | 2    | 3    | 3    | 3    |
| CO4    | -   | -   | -   | 3   | 3   | -   | -   | -   | 2   | 3    | 2    | 3    | 3    | 3    |

#### Syllabus

##### Unit I

Selected Topics in Probability and Random Variables -Memoryless property of exponential and geometric randomVariables -Moment generating function – Laplace-Stieljes transform (LST) of random variables - Selected Topics in Stochastic Processes –Stationarity –Ergodicity –Independence –Correlation - Stationary Increment and Independent Increment Processes - Bernoulli trials - Poisson processes - Gaussian processes.

##### Unit 2

Markov Processes -Discrete time Markov chains (DTMCs) -Continuous time Markov chains (CTMCs) - Recurrence –Transience –Stability - Renewal Processes and Markov Renewal Processes - Queueing Theory - Common queueing models (M/M/1, M/M/1/K, M/M/K/K, M/G/1, M/G/1/K, G/M/1, Geo/Geo/1, M/G/∞) - Vacation models -Loss networks and delay networks -Multiclass queueing models with priority -Open and closed networks of queues.

##### Unit 3

Discrete-Event Simulation of Queueing Systems - Applications to Telecommunications and Computer Communication Networks -Capacity design, Dynamic channel allocation in cellular networks and telecommunication switching -Throughput and delay analysis in wireless local area networks (WLANs) -Coverage analysis in wireless sensor networks (WSNs).

**Text book(s)**

Vidyadhar G. Kulkarni, "Modeling and Analysis of Stochastic Systems", CRC Press, 2016.

Anurag Kumar, "Discrete Event Stochastic Processes", available online  
<http://ece.iisc.ernet.in/~anurag/books/anurag/spqt.pdf>.

**Reference(s)**

Dimitri P. Bertsekas, and Robert G. Gallager, "Data Networks", Prentice Hall International, 1987.

Alberto Leon-Garcia, "Probability, Statistics, and Random Processes for Electrical Engineering", 3rd ed. Pearson/Prentice Hall, 2008.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):**Nil

### Course Objectives

- To familiarize students with quantitative techniques applied in business decision making scenarios
- To comprehend the mathematical methods to optimize the company resources and find optimal solution within constraints

### Course Outcomes

**CO1:** Identify, formulate and analyze models to optimize organizational resources and maximize profit

**CO2:** Choose the appropriate management tool to lead a team and provide solutions in complex decision making Scenarios

**CO 3:** Apply continuous learning and help improve company financials by efficiently managing projects

**CO 4:** Analyse the data and comprehend on performance based on scheduling, queueing and inventory

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | -   | -   | 3   | -   | -   | -   | 3   | 3   | 2    | 3    | 1    | -    | -    |
| CO2    | 3   | 1   | -   | 3   | -   | -   | -   | 3   | 3   | 2    | 3    | 1    | -    | -    |
| CO3    | -   | 3   | 3   | 3   | -   | -   | -   | 3   | 2   | 1    | 3    | 3    | -    | 1    |
| CO4    | -   | 1   | -   | 3   | -   | -   | -   | 3   | 3   | 1    | 3    | 2    | -    | -    |

### Syllabus

#### Unit 1

Evolution of OR - Fundamentals of OR Modelling Approach - Linear Programming – Assumptions – formulation -graphical method - simplex method - duality theory- primal-dual relationships - sensitivity analysis Transportation and Assignment Problems - Specific features and methods of transportation problem -Hungarian method for solving assignment problems - travelling salesman problem - Dynamic Programming – Characteristics - optimality principle -deterministic problems.

#### Unit 2

Network Models- Project Networks- CPM / PERT- Project Scheduling - crashing networks and cost considerations - Resource leveling and smoothing, shortest route problem - minimal spanning tree problem - maximal flow problem

Decision Theory - Decision making under uncertainty - decision trees - decision under risk – EMV, EOL, EVPI - Game theory - mixed strategies - dominance property - 2 x n and m x 2 games.

#### Unit 3

Flow shop scheduling– Johnsons algorithm for n jobs and two machines and n jobs and m machines - Inventory Models - Deterministic manufacturing and purchase models - quantity discounts Queueing models - Poisson arrival and exponential service times - Single server and multi-server model Simulation –Monte Carlo simulation - simple problems.

**Text book(s)**

Taha, H A, "Operations Research - An Introduction", Sixth Edition, Prentice Hall of India Private Limited, N. Delhi, 2004.

Ravindran, A., Phillips, D.J., and Solberg, J.J., "Operations Research- Principles and Practice", John Wiley & Sons, 2005.

**Reference(s)**

Wagner H M, "Principles of Operations Research", Second Edition, Prentice Hall of India Private Limited, New Delhi, 2003.

Hardley, G., "Linear Programming", Narosa Book Distributors Private Ltd 2002.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Linear Algebra

### Course Objectives

- To efficiently solve mathematical optimization problems which arise in a variety of applications
- To discover/identify various applications in areas such as, estimation and signal processing, communications and networks, electronic circuit design, data analysis and modeling, statistics, automatic control systems and finance

### Course Outcomes

**CO1:** Able to recognize, formulate, and analyze convex optimization problems

**CO2:** Able to design sophisticated algorithms based on convex Optimization for applications in communication and signal processing

**CO3:** Able to solve convex problems using computationally efficient techniques

**CO4:** Able to analyze and evaluate optimization techniques

### CO-PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 2   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 2    | -    |
| CO2    | 3   | 2   | 2   | 2   | -   | -   | -   | -   | -   | -    | -    | 2    | 2    | 2    |
| CO3    | 3   | 3   | 3   | 2   | -   | -   | -   | -   | -   | -    | -    | 2    | 2    | -    |
| CO4    | 3   | 3   | 2   | 2   | -   | -   | -   | -   | -   | -    | -    | 2    | 2    | 2    |

### Syllabus

#### Unit 1

Introduction - linear algebra fundamentals - Solving linear equations with factored matrices - Block elimination and

Schur complements - Convex sets - Convex functions – examples.

#### Unit 2

Classes of Convex Problems - Linear optimization problems - Quadratic optimization problems - Geometric programming - Vector optimization - Reformulating a Problem in Convex Form.

#### Unit 3

Lagrange Duality Theory and KKT Optimality Conditions - Interior-point methods- Primal and Dual Decompositions – Applications.

#### Text book(s)

*Stephen Boyd and LievenVandenberghe, "Convex Optimization", Cambridge University Press, 2004.*

*Daniel Palomar, "Convex Optimization in Signal Processing and Communications", CambridgeUniversity Press, 2009.*

#### Reference(s)

*Dimitri P Bertsekas, "Convex Optimization Theory", Athena Scientific, 2009.*

### Evaluation Pattern

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Nil

### Course Objectives

- To introduce the idea of artificial neural networks and their architecture
- To introduce techniques used for training artificial neural networks
- To enable design of an artificial neural network for classification
- To enable design and deployment of deep learning models for machine learning problems

### Course Outcomes

**CO1:** Able to understand the mathematics behind functioning of artificial neural networks

**CO2:** Able to analyze the given dataset for designing a neural network based solution

**CO3:** Able to carry out design and implementation of deep learning models for signal/image processing applications

**CO4:** Able to design and deploy simple TensorFlow-based deep learning solutions to classification problems

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1    | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO2    | -   | 3   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | -    |
| CO3    | -   | 2   | 3   | 2   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | -    |
| CO4    | 2   | 2   | 2   | 2   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |

### Syllabus

#### Unit 1

Artificial Neural Networks- The Neuron-Expressing Linear Perceptrons as Neurons-Feed-Forward Neural Networks- Linear Neurons and Their Limitations – Sigmoid – Tanh - and ReLU Neurons - Softmax Output Layers -

Training Feed-Forward Neural Networks-Gradient Descent-Delta Rule and Learning Rates- Gradient Descent with Sigmoidal Neurons- The Backpropagation Algorithm-Stochastic and Minibatch Gradient Descent - Test Sets - Validation Sets - and Overfitting- Preventing Overfitting in Deep Neural Networks - Implementing Neural Networks in TensorFlow.

#### Unit 2

Local Minima in the Error Surfaces of Deep Networks- Model Identifiability- Spurious Local Minima in Deep Networks- Flat Regions in the Error Surface - Momentum-Based Optimization - Learning Rate Adaptation.

#### Unit 3

Convolutional Neural Networks(CNN) - Architecture -Accelerating Training with Batch Normalization- Building a Convolutional Network using TensorFlow- Visualizing Learning in Convolutional Networks - Embedding and Representation Learning -Autoencoder Architecture-Implementing an Autoencoder in TensorFlow –Denoising-Sparsity in Autoencoders Models for Sequence Analysis - Recurrent Neural Networks- Vanishing Gradients-Long Short-Term Memory (LSTM) Units- TensorFlow Primitives for RNN Models-Augmenting Recurrent Networks with Attention.

**Text book(s)**

Nikhil Buduma, “Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithm”, O’Reilly, 2017.

Ian Goodfellow, YoshuaBengio and Aaron Courville, “Deep Learning”, MIT Press, 2016.

**Reference(s)**

AurélienGéron, “Hands-On Machine Learning with Scikit- Learn and TensorFlow”, O’Reilly, 2017.

Nikhil Ketkar, “Deep Learning with Python: A Hands-on Introduction”, Apress, 2017.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.



### Course Objectives

- To introduce the characteristics of natural agents and building blocks involved in biological processes
- To provide an understanding on the application of bio inspired algorithms to solve complex problems
- To provide insights into the implementation of bio inspired algorithms

### Course Outcomes

**CO1:** To understand phenomena guiding biological processes through self-organization and adaptability

**CO2:** To visualize the effect of low-level interactions on high-level phenomena

**CO3:** To analyze complex engineering problems and solve them by adapting biological processes suitably

**CO4:** To design and implement simple bio-inspired algorithms

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 2   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO2    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |
| CO3    | 2   | 3   | 2   | 2   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | 2    |
| CO4    | 2   | 2   | 3   | 3   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 3    |

### Syllabus

#### Unit 1

Artificial Neural Networks – Pattern classification – Single and Multilayer perceptrons – Backpropagation – Pattern Association – Hebbian learning – Hopfield networks – Bidirectional Associative Memory Networks – Competitive learning – Kohonen’s Self Organizing Maps.

#### Unit 2

Genetic algorithms – Representation – Reproduction - Crossover and Mutation Operators – Crossover and Mutation rates – Selection mechanisms – Fitness proportionate - ranking and tournament selection – Building Block - Hypothesis and Schema Theorem

#### Unit 3

Swarm Intelligence – Stigmergy – Competition and Cooperation – Particle Swarm Optimization – Anatomy of a particle – Velocity and Position updation– PSO topologies – Control parameters –Ant Colony Optimization – Pheromone updation and evaporation.

#### Text book(s)

Leandro Nunes De Castro, Fernando Jose Von Zuben, “Recent Developments in Biologically Inspired Computing”, Idea Group Publishing, 2005.

LaureneFausett, “Fundamentals of neural networks: architectures, algorithms, and applications”, Prentice-Hall, 1994.

#### Reference(s)

Goldberg, , ” Genetic algorithms in search optimization and machine learning”, Addison Wesley, 1999.

Xin-She Yang, “Recent Advances in Swarm Intelligence and Evolutionary Computation”, Springer International Publishing, Switzerland, 2015.

### Evaluation Pattern

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Nil

### Course Objectives

- To formalize the notions of strategic thinking and rational choice by using the tools of game theory
- To draw the connections between game theory and its applications in communications, signal processing and computer networking, emphasizing the computational issues
- To gain hands-on experience by seeing game-theoretic algorithms in action

### Course Outcomes

**CO1:** Ability to map communications, signal processing and networking problems into standard game-theoretic models

**CO2:** Ability to apply game-theoretic concepts to solve engineering problems and obtain insights

**CO3:** Ability to numerically implement game-theoretic design algorithms and investigate performance

**CO4:** Gain professional knowledge and skills by term projects

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -   | 3    | -    | 3    | 3    | 3    |
| CO2    | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -   | 3    | 2    | 3    | 3    | 3    |
| CO3    | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -   | 3    | 2    | 3    | 3    | 3    |
| CO4    | -   | -   | -   | 3   | -   | -   | -   | -   | 2   | 3    | 2    | 3    | 3    | 3    |

### Syllabus

#### Unit 1

Introduction to Game Theory- Non-cooperative games - strategic form vs. dynamic - Bayesian games - static vs. dynamic games in extensive form - Differential games - connections with optimal control theory.

#### Unit 2

Evolutionary games - evolutionarily stable strategies - replicator dynamics - reinforcement learning - Cooperative Games – bargaining - coalitional games - Auction theory and mechanism design - VCG auction.

#### Unit 3

Application to Communication Networks - Applications to cellular and broadband wireless access networks - Applications to wireless local area networks - Applications to multihop networks - Applications to cooperative communication networks - Applications to Cognitive radio networks - Applications to Internet congestion control and Net Neutrality.

#### Text book(s)

*M. J. Osborne, "An Introduction to Game Theory", Oxford University Press, 2003.*

*Han, Zhu, DusitNiyato, WalidSaad, Tamer Başar, and Are Hjørungnes, "Game theory in wireless and communication networks: theory, models, and applications", Cambridge university press, 2012.*

#### Reference(s)

*MacKenzie, Allen B., and Luiz A. DaSilva, "Game Theory for Wireless Engineers", Synthesis Lectures on Communications, 1, no. 1 (2006): 1-86.*

*N. Nisan, T. Roughgarden, E. Tardos, and V. V. Vazirani, "Algorithmic Game Theory", Cambridge University Press, 2007.*

### Evaluation Pattern

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Probability and Random Processes

### Course Objectives

- To understand the concept of pattern and the basic approach in developing pattern recognition algorithms
- To develop prototype pattern recognition algorithms that can be applied against real-world multivariate data
- To effectively implement pattern recognition algorithms for specific applications using simulation tools

### Course Outcomes

**CO1:** Able to apply the knowledge of mathematics for obtaining solutions in pattern recognition domain

**CO2:** Able to apply various algorithms for pattern recognition

**CO3:** Able to map the pattern recognition concepts for solving real life problems

**CO4:** Able to carry out implementation of algorithms using different simulation tools

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | -   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |
| CO2    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |
| CO3    | 3   | 3   | 2   | 2   | -   | -   | -   | -   | 2   | -    | -    | -    | 2    | 2    |
| CO4    | 3   | 2   | 3   | -   | -   | -   | -   | -   | 2   | -    | -    | -    | 2    | -    |

### Syllabus

#### Unit 1

Introduction - Applications of pattern recognition -Probability distribution basics - Discrete distributions and Continuous distributions - Conditional probability distribution and Joint probability distribution - Statistical decision

Making – Introduction - Bayes’ theorem - conditionally independent features - Naïve bayes classifier - Decision Boundaries - Unequal costs of error - Estimation of error rates.

#### Unit 2

Nonparametric decision making – Introduction – histograms - K nearest neighbor method - adaptive decision Boundaries - adaptive discriminant functions - minimum squared error discriminant functions - Artificial neural Networks - Logistic regression – Perceptron - Multilayer feed forward neural network – Gradient descent method - back propagation -Dimensionality Reduction Techniques - Principal component analysis - Fisher discriminant analysis.

#### Text book(s)

*Earl Gose, Richard Johnsonbaugh, Steve Jost, “Pattern Recognition and Image Analysis”, Prentice Hall India Private Limited, 2003.*

*Bishop, Christopher M, “Pattern recognition and Machine Learning”, Springer, 2006.*

**Reference(s)**

Duda, Richard O., Peter E. Hart, and David G. Stork, "Pattern classification", John Wiley & Sons, 2012.  
Fausett, Laurene V., "Fundamentals of neural networks: architectures, algorithms, and applications", Vol. 3. Englewood Cliffs: Prentice-Hall, 1994.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Nil

### Course Objectives

- To understand the functioning of financial markets and the behavior of financial time series
- To provide an introduction to application of signal processing techniques for identifying and forecasting patterns in financial time series
- To develop an understanding of the process for design of a profitable trading system

### Course Outcomes

**CO1:** Able to understand the structure of financial markets and asset pricing models

**CO2:** Able to analyze a financial time series and employ technical analysis to identify patterns in it

**CO3:** Able to employ filters for detection and analysis of business cycles

**CO4:** Able to design an adaptive filter based system for predicting financial time series

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 2    | -    |
| CO2    | 2   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 2    | -    |
| CO3    | 2   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 2    | 2    |
| CO4    | -   | 2   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 2    | 2    |

### Syllabus

#### Unit 1

Structure of financial markets-financial instruments-stock price models-asset returns-modern portfolio theory-capital asset pricing model-relative value and factor models -Trading terminology-long and short positions-cost of trading – backtesting-pairs trading and mean reversion-statistical arbitrage-trend following- trending in multiple frequencies.

#### Unit 2

Measuring business cycles- The Hodrick – Prescott filter – Baxter– King filter - Technical Analysis – Indicators –Oscillators- Signal to noise ratio - Sine wave indicator – Instantaneous trend line - Identifying market modes– Transform arithmetic – FIR – IIR - Removing lag - Adaptive moving averages - Ehlers filters.

#### Unit 3

Measuring market spectra - optimum predictive filters - Adapting standard indicators- High frequency trading- Designing profitable trading system.

#### Text book(s)

Ali N. Akansu and Mustafa Torun, “A Primer for Financial Engineering: Financial Signal Processing and Electronic Trading”, Academic Press, 2015.

RamazanGencay, FarukSelcuk& Brandon Whitdly, “An Introduction to Wavelets and other filtering methods in Finance and Economics”, Academic Press, 2002.

**Reference(s)**

John F Ehlers, "Rocket Science for Traders: Digital Signal Processing Applications", John Wiley 2001.  
Jack Clark Francis, Richard W. Taylor, "Investments, Schaum's Outlines", Tata McGraw Hill, 2006.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |
|                             |          |          |

\*CA – Can be Quizzes, Assignment, Projects, and Reports



**Pre Requisite(s):** Nil

### Course Objectives

- To understand dynamical systems using maps and flows
- To familiarize with methods for detection and quantification of chaos in time series data
- To comprehend the need and use of nonlinear analysis for chaotic signals

### Course Outcomes

**CO1:** Demonstrate the ability to understand the concepts underlying dynamical systems

**CO2:** Analyze and model dynamical systems using computational methods

**CO3:** Critically evaluate the requirements for analyzing chaotic signals

**CO4:** Apply non-linear methods to characterize biological data

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | -   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 1    | -    |
| CO2    | -   | 2   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | -    |
| CO3    | -   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 2    | -    |
| CO4    | -   | -   | -   | 3   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | -    |

### Syllabus

#### Unit 1

Introduction to dynamical systems and chaos – deterministic versus stochastic systems – state space - phase space - fixed points and its stability- chaos- Lyapunov exponent - maps - logistic map -Henon map.

#### Unit 2

Flows –harmonic oscillator – butterfly effect – Lorenz attractor- Rossler attractor – introduction to fractals - dimensionality of fractals - quantifying chaos using fractals.

#### Unit 3

Time series properties – chaos in biological signals - conventional linear methods limitation – alternate methods –time-delay embedding, entropy- complexity measures.

#### Text book(s)

*Alligood KT, Sauer TD and Yorke JA, “Chaos”, First Edition, Springer New York; 1996.*

*Strogatz SH, “Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering”, First Edition, CRC Press, 2001.*

#### Reference(s)

*Sprott JC, “Chaos and time-series analysis”, First Edition, Oxford University Press; 2003.*

*Ditto, William L. “Applications of chaos in biology and medicine”, AIP Conference Proceedings. Vol. 376. No. 1. AIP, 1996.*

### Evaluation Pattern

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Nil

### Course Objectives

- To introduce the concept of artificial agents
- To provide an understanding of the features and design considerations for developing a multi-agent system
- To provide an overview of the applicability of data mining techniques for design of intelligent agents

### Course Outcomes

**CO1:** Able to apply the concepts of data mining for designing a simple agent based model

**CO2:** Able to analyze the given problem and formulate an agent-based solution

**CO3:** Able to design a simple multi-agent system model to solve complex engineering problems

**CO4:** Able to carry out design and simulation of artificial agents using agent based modeling software

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1    | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO2    | -   | 3   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | -    |
| CO3    | -   | 2   | 3   | 2   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | -    |
| CO4    | 2   | 2   | 2   | 2   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |

### Syllabus

#### Unit 1

Introduction to Agents – Features - Classification of agents. Multi Agent Systems (MAS) and properties - Agent communication ontology - Agent communication languages. Internal structure of MAS: Shell – Reasoning engine. -MAS development methodology - Agent behavior - Agent action - Knowledge diffusion in MAS - Application level -behavior level and evolutionary agent communities.

#### Unit 2

Data mining techniques for intelligent Agents - Association rule mining – Clustering - Classification and evolutionary algorithms.

#### Unit 3

Applying data mining to agents - Study of available agent based modeling software- Case studies - Application level - behavior level and evolutionary agent communities.

#### Text book(s)

*A. L. Symeonidis, P. A. Mitkas, “Agent Intelligence through Data Mining”, Springer, 2005.*

*Uri Wilensky, William Rand, “An Introduction to Agent-Based Modeling”, MIT Press, 2015.*

#### Reference(s)

*M. Mohammadian, “Intelligent Agents for Data Mining and Information Retrieval”, Idea Group Publishing 2003*

*D. L. Poole, A. K. Mackworth, “Artificial Intelligence: Foundations of Computational Agents”, Cambridge University Press, 2010.*

### Evaluation Pattern

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Nil

### Course Objectives

- To develop basic understanding of mathematical concepts behind robot dynamics
- To provide the basic understanding of mobile robot navigation techniques
- To develop a basic understanding of SLAM
- To understand the dynamics and control of arm-type robots

### Course Outcomes

**CO1:** Able to understand different types of robot navigation techniques

**CO2:** Able to understand different types of robot localization techniques

**CO3:** Able to compute the forward and inverse kinematics of a robotic arm

**CO4:** Able to analyze the dynamics of an arm-type robot

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | -   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO2    | 3   | -   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO3    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | 2    |
| CO4    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | 2    |

### Syllabus

#### Unit 1

Representing Position and Orientation-Orientation and pose in 2D and 3D - Normalization-exponential mapping –twists -Dual Quaternions-Configuration Space - Time and Motion -Time-Varying Pose -Accelerating Bodies and Reference Frames -Creating Time-Varying Pose –Applications.

#### Unit 2

Mobile Robot Vehicles -Wheeled Mobile Robots -Flying Robots -Navigation-Reactive Navigation -Map-Based Planning – Localization -Dead Reckoning -Localizing with a Map - Creating a Map - Localization and Mapping - Rao-Blackwellized SLAM - Pose Graph SLAM - Sequential Monte-Carlo Localization – Applications.

#### Unit 3

Arm -Type Robots-Forward Kinematics -Inverse Kinematics –Trajectories - Manipulator Velocity -Manipulator Jacobian -Jacobian Condition and Manipulability -Resolved-Rate Motion Control -Under and Over-Actuated Manipulators -Force Relationships -Inverse Kinematics -Computing the Manipulator Jacobian Using Twists - Dynamics and Control -Independent Joint Control -Rigid-Body Equations of Motion -Forward Dynamics –Rigid-Body Dynamics Compensation.

#### Text book(s)

Peter Corke, *Robotics, "Vision and Control: Fundamental Algorithms in MATLAB", 2<sup>nd</sup> Ed., Springer, 2017.*

Kevin M. Lynch and Frank C. Park, *"Modern Robotics: Mechanics, Planning, and Control", Cambridge University Press, 2017.*

**Reference(s)**

*S K Saha, Introduction To Robotics, 2<sup>nd</sup> Ed., McGraw-Hill, 2014.*

*R. K. Mittal and I. J. Nagrath, Robotics and control, McGraw-Hill, 2003.*

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports.

## Communication Engineering

19CCE431

SOFTWARE DEFINED NETWORKS

L-T-P-C: 3-0-0-3

**PreRequisite(s):** Computer Networks

### Course Objectives

- To learn about Software Defined Networking (SDN) foundations and emerging Internet architectural framework
- To explore the SDN concepts, architectures, algorithms, protocols and applications related topics including Data Center Networks
- To study and experience about Network Function Virtualization (NFV) and SDN ECO systems

### Course Outcomes

**CO1:** Able to understand Networking basics and necessity and genesis of Software defined Networking

**CO2:** Able to understand various SDN Architectures and Network Function Virtualization

**CO3:** Able to explore emerging SDN models

**CO4:** Able to implement simple SDN protocols using programming language

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 2   | 1   | -   | -   | 2   | -   | -   | -   | 2    | 2    | 2    | 3    | 3    |
| CO2    | 3   | 2   | 1   | -   | -   | 2   | -   | -   | -   | 2    | 2    | 2    | 3    | 3    |
| CO3    | 3   | 2   | 1   | -   | -   | 2   | -   | -   | -   | 2    | 2    | 2    | 3    | 3    |
| CO4    | 3   | 2   | 3   | 3   | -   | 2   | -   | -   | 3   | 2    | 2    | 2    | 3    | 3    |

### Syllabus

#### Unit 1

Networking Basics: Switching – Addressing - Routing - Switching Architecture – Data – Control - and Management

Lanes - Forwarding Rules - Autonomous Switches and Routers - Why SDN? - Evolution of Switches and ControlLanes – Cost - Data Center Innovation - Data Center Needs - Genesis of SDN -Forerunners of SDN - Open Source Contributions.

#### Unit 2

SDN Architecture: Fundamental Characteristics of SDN – Operation – Devices - SDN Controllers -OpenDaylight and ONOS - SDN Applications - Northbound and Southbound APIs –OpenFlow - Switch-Controller Interaction - Flow Table - Packet Matching - Actions and Packet Forwarding - Extensions and Limitations - Network Function Virtualization (NFV) - SDN vs. NFV – OPNFV - Inline Network Functions - NFV Orchestration.

#### Unit 3

Emerging SDN Models: Protocol Models – NETCONF – BGP – MPLS - Controller Models - Application Models - Proactive – Declarative – External - SDN in Datacenters – Multitenancy - Failure Recovery - SDN in Internet eXchangePoints (IXPs) - SDN Ecosystem - White-box switching - Open Sourcing SDN - Open Networking FoundationOpenDaylight – ONOS –OpenStack -OpenSwitch - Programming Assignments for implementing some of the theoretical - concepts listed above.

**Text book(s)**

Goransson P, Black C, Culver T., "Software Defined Networks: A Comprehensive Approach", s.l: Elsevier Science; 2016.

Gray K, Nadeau TD., "Network Function Virtualization", Amsterdam Boston Heidelberg: Morgan Kaufmann; 2016.

**Reference(s)**

Nadeau TD, Gray K., "SDN: Software Defined Networks", [an Authoritative Review of Network Programmability Technologies], 1. ed. Beijing: O'Reilly; 2013.

Hu F, ed., "Network Innovation through OpenFlow and SDN: Principles and Design", Boca Raton London New York: CRC Press, Taylor & Francis Group, CRC Press is an imprint of the Taylor & Francis Group, an informa business; 2014.

Qi H, Li K., "Software Defined Networking Applications in Distributed Datacenters", Cham: Springer International Publishing; 2016. doi:10.1007/978-3-319-33135-5.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports



**PreRequisite(s):** Digital Communication

### Course Objectives

- To develop mathematical theory of digital communications over fading channels
- To learn multicarrier techniques for fading wireless channels
- To analyzes and design of multi-channel techniques for communication
- To understand the synchronization issues in multicarrier environment

### Course Outcomes

**CO1:** Ability to apply knowledge of design processes in multicarrier systems

**CO2:** To generate innovative designs to fulfil new needs, particularly in the fields of broadband networks and mobile communication systems

**CO3:** Able to analyze the performance of multicarrier system in wireless cellular systems

**CO4:** Understand the concepts of channel estimation in fading channels

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | -    |
| CO2    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | -    |
| CO3    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | -    |
| CO4    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 2    | -    |

### Syllabus

#### Unit 1

Introduction-High Rate Wireless Applications -Single-Carrier vs. Multi-Carrier Transmission - Introduction to OFDM -Basic Principle of OFDM -Modeling of OFDM for Time-Varying Random Channel-Appropriate Channel Model for OFDM Systems -Impairments of Wireless Channels to OFDM Signals -Application to Millimeter-Wave Radio Channels.

#### Unit 2

Coded OFDM-Multiple Access Extensions of OFDM–Multiband OFDM-MIMO OFDM -Performance Optimization -Channel Partitioning -Synchronization -Timing Offset Estimation -Frequency Offset Estimation - Synchronization in Cellular Systems.

#### Unit 3

Channel Estimation -Pilot Structure -Training Symbol-Based Channel Estimation -DFT-Based Channel Estimation – Decision-Directed Channel Estimation -PAPR Reduction-Inter-Cell Interference Mitigation Techniques.

#### Text book(s)

*Ye (Geoffrey) Li and Gordon L. Stuber, “Orthogonal Frequency Division Multiplexing for Wireless Communications”, Springer, 2006.*

*Ramjee Prasad, “OFDM for Wireless Communications Systems”, Artech House, 2004.*

**Reference(s)**

Bahai, Saltzberg and Ergen, Multi-Carrier, "Digital Communications, Theory and Applications of OFDM", Second Edition, Springer, 2004.

Henrik Schulze and Christian Lueders, "Theory and Applications of OFDM and CDMA Wideband Wireless Communications", John Wiley and Sons, 2005.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):**Digital Communication

### Course Objectives

- To introduce the concepts of crowded spectrum and need for high data rates
- To understand the design of spectral efficient and reliable spatial diversity techniques
- To comprehend the design of broadband wireless systems

### Course Outcomes

**CO1:** Able to understand the spectral limitations in the design of reliable and high data rate communication Systems

**CO2:** Able to analyze the spectrally efficient communication techniques to proposed design solutions for high data rate wireless systems and principles to propose design solutions for high data rate wireless systems

**CO3:** Able to conduct investigations and provide viable solutions in the field of communication

**CO4:** Able to apply the contextual knowledge in design , development of solutions of complex engineering problems

**CO5:** Able to learn the emerging wireless communication standards

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO2    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | 2    |
| CO3    | -   | 3   | 3   | 3   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |
| CO4    | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO5    | 3   | -   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 3    | -    | -    |

### Syllabus

#### Unit 1

Introduction - Crowded spectrum - Need for high data rates – Multiple input multiple output systems – Multi antenna systems and concepts - Spatial multiplexing - MIMO system model- MIMO system capacity- Channel known to the transmitter - Channel unknown to the transmitter - Water-pouring principle – Capacity calculation – SIMO - MISO - Ergodic capacity - Outage capacity – Influence of fading Correlation on MIMO capacity – Influence of LOS on MIMO capacity.

#### Unit 2

Delay diversity scheme- Alamouti space - time code - Maximum likelihood decoding - Maximum ratio combining - Transmit diversity - Space-time block codes - STBC for real signal constellations - Decoding of STBC-OSTBC –Capacity of OSTBC channels - Space-time code Word design criteria – Multiplexing architecture - VBLAST Architecture.

#### Unit 3

Data transmission over multipath channels - Single carrier approach - Multicarrier approach - OFDM - OFDM generation - Cyclic prefix - Performance of space - Time coding on frequency-Selective fading channels- Capacity of MIMO - OFDM systems - Performance analysis of MIMO-OFDM systems.

**Text book(s)**

MohinderJanakiram, "Space time Processing and MIMO Systems", Artech House, First Edition, 2004.  
ArogyaswamiPaulraj, RohitNabar, Dhananjay Gore, "Introduction to Space-Time Wireless Communications", Cambridge University Press, 2008.

**Reference(s)**

Hamid Jafarkhani, "Space Time coding-Theory and Practice", Cambridge University Press, First Edition, 2005.  
David Tse, PramodViswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2005.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**PreRequisite:** Digital Communication

### Course Objectives

- To provide foundation in spreading techniques and gives insight of scrambling effect, anti-jamming, Low probability of detection
- To provide an insight of Galois fields and primitive polynomials
- To provide an introduction to traditional and modern techniques of synchronization and tracking

### Course Outcomes

**CO1:** Able to understand principles of spread spectrum systems, and anti-jamming

**CO2:** Able to analyse the various spreading code generation techniques

**CO3:** Able to understand principles of finite fields and primitive polynomials

**CO4:** Able to analyse the performance spreading code acquisition and tracking

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | -    |
| CO2    | 3   | 2   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | -    |
| CO3    | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO4    | 3   | 3   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |

### Syllabus

#### Unit 1

Introduction to spread spectrum - Direct sequence spread spectrum - Spreading sequences and Waveforms – Pseudo-random sequence generation - Maximal sequences - Autocorrelations and Power spectrums of codes - Characteristic polynomials - Generation of gold codes – Interference rejection for DS/SS. Frequency hopping spread spectrum - Frequency synthesizers - Multitone jamming - Hybrid systems.

#### Unit 2

Synchronization issues for spread-spectrum - Phase lock loop - Delay lock loop - Acquisition of spreading sequences – Serial search acquisition - Introduction to code tracking.

#### Unit 3

Detection of spread spectrum signals - Performance of direct sequence spread spectrum - Performance of frequency hopped spread spectrum - Performance of spread spectrum system with forward error correction - Low probability of detection - Code division multiple access (CDMA).

#### Text book(s)

*Roger L Peterson, Rodger E Ziemer, David E Borth, "Introduction to Spread Spectrum Communication", Pearson Education, First Edition, 2013.*

*John. G. Proakis & Masoud Salehi, "Digital Communication", Tata McGraw Hill Publishing Company Limited, Fifth Edition, 2009.*

**Reference(s)**

Rappaport, T. S, "Wireless Communications", Pearson Education Asia, 2003, Edition.

Don Torrieri, "Principles of Spread-Spectrum Communication Systems", Second Edition, Springer New York Dordrecht Heidelberg London.2011.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Nil

### Course Objectives

- To understand the characteristics and architecture of wireless sensor network
- To understand Physical and MAC layers in protocol stack and analyze various design considerations
- To attain a knowledge of Routing techniques and Data gathering Protocols
- To analyze and interpret wireless sensor network design in different applications scenario

### Course Outcomes

**CO1:** Able to understand characteristics and architecture of wireless sensor network

**CO2:** Able to understand Physical and MAC layers in protocol stack and analyze its various design considerations

**CO3:** Able to understand various routing techniques in wireless sensor networks

**CO4:** Able to analyze and interpret wireless sensor network design in different applications scenario

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 1   |     | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO2    | 3   | 2   | 1   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO3    | 3   | 1   | 1   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO4    | 2   | 2   | 2   | -   | -   | -   | -   | -   | 1   | -    | -    | -    | -    | -    |

### Syllabus

#### Unit 1

Introduction to WSN - Characteristic requirements for WSN - Challenges for WSNs – WSNvsAdhoc Networks – Sensor node architecture – Commercially available sensor nodes – Imote - IRIS, Mica Mote - EYES nodes, BTnodes – TelosB - Sunspot - Physical layer and transceiver design considerations in WSNs - Energy usage profile - Choice of modulation scheme - Dynamic modulation scaling - Antenna considerations - Medium Access Control Protocols - Fundamentals of MAC protocols - Low duty cycle protocols and wakeup concepts – Contentionbased protocols - Schedule-based protocols - SMAC - BMAC - Traffic-adaptive medium access protocol (TRAMA) - The IEEE 802.15.4 MAC protocol.

#### Unit 2

Routing and Data Gathering Protocols - Routing Challenges and Design Issues in Wireless Sensor Networks - Flooding and gossiping – Data centric Routing – SPIN – Directed Diffusion – Energy aware routing – Gradient-based routing - Rumor Routing – COUGAR – ACQUIRE – Hierarchical Routing - LEACH, PEGASIS – Location Based Routing – GF – GAF – GEAR - GPSR – Real Time routing Protocols – TEEN - APTEEN – SPEED - RAP - Data aggregation - data aggregation operations - Aggregate Queries in Sensor Networks - Aggregation Techniques – TAG, Tiny DB.

### Unit 3

Embedded Operating Systems - Operating Systems for Wireless Sensor Networks – Introduction - Operating System Design Issues - Examples of Operating Systems – TinyOS – Mate – MagnetOS – MANTIS - OSPM – EYES OS – SenOS – EMERALDS – Pic OS Applications of WSN - WSN Applications - Home Control – Building Automation - Industrial Automation - Medical Applications - Reconfigurable Sensor Networks - Highway Monitoring - Military Applications - Civil and Environmental Engineering Applications - Wildfire Instrumentation

- Habitat Monitoring - Nanoscopic Sensor Applications – Case Study - IEEE 802.15.4 LR-WPANs Standard – Target detection and tracking - Contour/edge detection - Field sampling.

#### **Text book(s)**

Holger Karl and Andreas Willig, “*Protocols and Architectures for Wireless Sensor Networks*”, John Wiley & Sons, Ltd, 2005.

KazemSohraby, Daniel Minoli and TaiebZnati, “*Wireless Sensor Networks Technology, Protocols, and Applications*”, John Wiley & Sons, 2007.

#### **Reference(s)**

K. Akkaya and M. Younis, “*A survey of routing protocols in wireless sensor networks*”, Elsevier Ad Hoc Network Journal, Vol. 3, no. 3, pp. 325–349.

Anna Ha’c, “*Wireless Sensor Network Designs*”, John Wiley & Sons Ltd.

#### **Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports



**Pre Requisite(s):** Digital Communication

### Course Objectives

- To understand the evolution of mobile radio communication system
- To explore the basic cellular concepts and its performance analysis
- To understand wireless channel propagation model, signal processing techniques and different architecture of cellular standards

### Course Outcomes

**CO1:** Able to understand the evolution of mobile radio communication system

**CO2:** Able to understand and analyze the basic cellular concepts with its performance measure

**CO3:** Able to understand various wireless channel propagation model and signal processing techniques

**CO4:** Able to explore the architecture of modern cellular standards

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 2   | 1   | 1   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | 3    |
| CO2    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | 3    |
| CO3    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | 3    | 3    | 3    |
| CO4    | 3   | 2   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | 3    |

### Syllabus

#### Unit 1

Introduction to cellular mobile systems - Basic Cellular System - Cellular communication infrastructure: Cells – clusters - Cell Splitting - Frequency reuse concept and reuse distance calculation - Cellular system components – Operations of cellular systems – Handoff / Handover - Channel assignment - Fixed and dynamic - Cellular Interferences - Co-Channel and adjacent channel and sectorization.

#### Unit 2

Channel Models - Properties of mobile radio channels - Intersymbol interference - Multipath and fading effects – Interleaving and diversity - Multiple access schemes (TDMA, FDMA, CDMA, SDMA) – Interuser interference – Traffic issues and cell capacity - Power control strategies - Channel assignment – Handoff.

#### Unit 3

Introduction to modern cellular standards - 2G Architecture such as GSM and CDMA based - 2.5G- GPRS – GPRS and its features - GPRS network architecture - GPRS protocol architecture - GPRS backbone network - 3G standard details such as UMTS - Introduction to LTE.

#### Text book(s)

Theodore S., Rappaport, “Wireless Communications Principles and Practice”, Second Edition, PHI, 2002.

Gottapu Sasibhushana Rao, “Mobile Cellular Communication”, Pearson Education, 2012.

#### Reference (s)

Andrea Goldsmith, “Wireless Communications”, Cambridge University Press, 2005.

William Stallings, “Wireless Communication and Networking”, PHI, 2003.

### Evaluation Pattern

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Digital Communication

### Course Objectives

- Understand the applications of and fundamental principles vehicular communications
- Gain knowledge about the emerging technologies and standards in the area of vehicular communication systems and networks
- Appreciate the challenges and design considerations of vehicle-to-anything (V2X) communications at various networking layers

### Course Outcomes

**CO1:** Ability to understand the theories, principles, technologies, standards and system architecture of vehicular communication networks

**CO2:** Ability to design and evaluate vehicular communication technologies for various safety and infotainment applications

**CO3:** Ability to appreciate the challenges and design considerations of V2X communication systems at various networking layers

**CO4:** Gain professional knowledge and skills through mini projects

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1    | 3   | -   | 3   | 3   | -   | -   | -   | -   | -   | -    | -    | 3    | 3    | 3    |
| CO2    | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -   | -    | -    | 3    | 3    | 3    |
| CO3    | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -   | -    | -    | 3    | 3    | 3    |
| CO4    | -   | 3   | 3   | 3   | -   | 3   | 3   | 3   | -   | -    | -    | 3    | 3    | 3    |

### Syllabus

#### Unit 1

Applications of V2X -Safety vs. non-safety - Use cases - Service requirements - Mapping service requirements to communication technologies -Protocol Layering and Standards -Fundamental principles of protocol layering - DSRC/WAVE - ETSI ITS-G5 and ARIB architectures - DSRC standard –Channelization - SAE J2735 message set dictionary - Basic Safety Message - IEEE 1609 WAVE multi-channel operation - IEEE 802.11p MAC and PHY.

#### Unit 2

Vehicular Wireless Channel Characteristics –Pathloss - shadowing and small-scale fading - Delay spread and Dopplerspread - Coherence bandwidth and coherence time - Impact of channel impairments on system design - Techniques for combating noise and vehicular channel impairments - Digital modulation schemes in 802.11p – Diversity - Equalization - Multicarrier modulation and OFDM - Design of OFDM parameters in 802.11p (symbol time, sub-carrier spacing - pilot spacing) - Transmit power control and transmit masks.

#### Unit 3

Routing in VANETs -Flooding and the ‘Broadcast Storm Problem’ - Traditional MANET routing -Topology based / table-driven routing protocols - Proactive (DSDV) vs. reactive / on-demand (DSR, AODV, DYMO) routing Protocols - Geographic routing protocols - Beaconing; DTN and peer-to-peer ideas for VANET routing.

**Text book(s)**

Christophe Sommer and Falko, Dressler, “Vehicular Networking”, Cambridge University Press, 2014.

Hannes Hartenstein and Kenneth Laberteaux (eds.), “VANET Vehicular Applications and Inter-networking Technologies”, John Wiley & Sons, 2009.

**Reference(s)**

Claudia Campolo, AntonellaMolinaro and Riccardo Scopigno, “Vehicular ad hoc Networks: Standards, Solutions, and Research”, Springer, 2015.

Andrea Goldsmith, “Wireless Communications”, Cambridge University Press, 2005.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Digital Communication

**Course Objectives**

- To introduce the indoor physical layer characteristics of gigabit communication systems
- To impart insights of fading channel parameter evaluation and study of statistical channel models
- To facilitate the importance of signal processing techniques to mitigate the channel impairments

**Course Outcomes**

**CO1:** Able to understand the indoor propagation characteristics for the analysis of gigabit wireless communication Systems

**CO2:** Able to comprehend the standards and principles to propose design solutions for high data rate wireless systems

**CO3:** Able to conduct investigations and provide valid conclusions in the field of communication

**CO4:** Able to apply the contextual knowledge in design , development of solutions of complex engineering problems

**CO5:** Able to learn the emerging wireless communication standards

**CO – PO Mapping**

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO2    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | 2    |
| CO3    | -   | 3   | 3   | 3   | -   | -   | 3   | -   | -   | -    | -    | -    | 2    | -    |
| CO4    | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO5    | 3   | -   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 3    | -    | -    |

**Syllabus**

**Unit 1**

Indoor propagation modeling - Introduction – Interference - Indoor propagation effects - ITU indoor path loss model - Long distance path loss model - link budget - Millimeter Wave (MMW) characteristics - MMW characteristics - 60 GHz MMW radio -Principle and technology - Channel performance at 60 GHz – Gigabit wireless communications - Development of MMW standards - Coexistence with wireless backhaul.

**Unit 2**

Review of modulations for MMW communications - PSK – OFDM - MMW transceivers -Transceiver architecture -MMW antennas - Path loss and antenna directivity - Antenna beamwidth – Beamsteering antenna.

**Unit 3**

MMW MIMO - Spatial diversity of antenna arrays - Multiple antennas - Multiple transceivers - Noise coupling in a

MIMO system - Potential benefits of advanced diversity for MMW - Spatial and temporal diversity - Spatial and frequency diversity - Dynamic spatial - Frequency and modulation allocation - Advanced beamsteering and beamforming - The need for beamsteering / beamforming - MMW applications.

**Text book(s)**

Kao-Cheng Huang, Zhoacheng Wang, "Millimeter Wave Communication Systems", Wiley IEEE press, 2011.  
Theodore S.Rappaport, Robert W. Heath Jr. Robert C. Daniels and James N. Murdock, "Millimeter Wave Wireless Communication", Prentice Hall, 2014.

**Reference(s)**

John S. Seybold, "Introduction to RF propagation", John Wiley and Sons, 2005.  
Chia-Chin Chong, Kiyoshi Hamaguchi, Peter F. M. Smulders and Su-Khiong, "Millimeter - Wave Wireless Communication Systems: Theory and Applications", Hindawi Publishing Corporation, 2007.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):**Nil

### Course Objectives

- To understand the application of wireless communication Protocols, TCP/IP, Satellite communication
- To analyze the regulation and standards of telecom regulatory bodies and Performance criteria
- To carry out investigation of spectrum Management and Business on Bandwidth
- To develop and design networks modeling and system evaluation for disaster management

### Course Outcomes

**CO1:**To acquire basic knowledge of the applications of wireless communication Protocols, TCP/IP, Satellite Communication

**CO2:** Able to analyze the regulation and standards of telecom regulatory bodies. Performance criteria

**CO3:** Able to apply cost computation for electronic components such as mobile, Wi-Fi and DTH operators

**CO4:** Able to carry out investigation of Frequency Management and Business on Bandwidth

**CO5:** To design the networks modeling and system evaluation

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO2    | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO3    | 2   | 2   | -   | 2   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO4    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO5    | 2   | 2   | 2   | 2   | -   | -   | -   | -   | 2   | 2    | 2    | -    | 2    | -    |

### Syllabus

#### Unit 1

Telecommunication Technology Fundamentals - Signal transmission and channels – Network media – Data compression – Protocols and topology – Connectivity in networks – Ethernet principles – Wireless communication principles – Broadcasting versus link - TCP/IP model – OSI model, Telecom network management: LAN – WAN – Repeaters – Bridges – Routers – Gateways – Hubs - Electronic commerce - Internet and intranet – Role of government in data communication quality of service in telecommunication - Telecommunication Standards and Regulations - International telecommunication union (ITU) - TRAI and its role – Frequency management – Cost computations – Mobile and DTH operations – Role of wireless planning commission (WPC) for telecommunications in India - Service providers.

#### Unit 2

Telecom business management - Automated teller machines – Teleconferencing – Telecommuting – Enterprise applications – Customer oriented communication aspects – Telecom billing - Revenue assurance & fraud management - Business on Spectrum - Concepts of data rate and bandwidth requirements – Digital subscriber line – Broadband technologies – Digital home – Voice enabled DSL - Bandwidth brokerage.

#### Unit 3

Telecommunication project management - Telecommunication design and implementation – Network analysis and design – Sources of projects – Methodology for designing, developing and implementing telecommunication capabilities – Disaster Management - Network modeling – Phases of project management.

**Text book(s)**

William C. Y. Lee, "Wireless & Cellular Telecommunications", McGraw-Hill Companies Inc, Third Edition, 2006.

Vincent W. S. Wong, "Key Technologies for 5G Wireless Systems", Cambridge University Press, 2017.

**Reference(s)**

John G. Proakis and MasoudSalehi, "Fundamentals of Communication Systems, Pearson Education", First Edition, 2007.

Simon Haykin, "Digital Communications", Wiley India Private Limited, First Edition, 2006.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports



### Course Objectives

- To introduce concept of engineering design for avionics systems
- To impart knowledge in Fault Detection methodologies
- To make aware the various generations of avionics evolution
- To help understand the physical principles behind the functioning of manifold avionics sensor systems

### Course Outcomes

**CO1:** Able to understand Concept of avionics systems engineering design

**CO2:** Able to understand Fault Detection methodologies

**CO3:** Able to understand the principles in various generations of avionics evolution

**CO4:** Able to understand physical principles of avionics sensor systems

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | -   | -   | -   | -   | -   | -   | -   | -   | -    | 2    | -    | 2    | -    |
| CO2    | 3   | 3   | -   | 3   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |
| CO3    | 2   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | -    |
| CO4    | 3   | 3   | -   | 2   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | -    |

### Syllabus

#### Unit 1

Introduction to avionics - Component specifications - Packaging standards - LRU - LRM - IMA - Backplanes – PXIe, VME - System design parameters - Traceability - Ilities - Fault tolerance and recovery - FMEA – FT.

#### Unit 2

Avionics architecture - PAVE PILLAR - PAVE PACE - JIAWG - Systems Integration - Databus topologies & Word formats - MIL-STD 1553B - ARINC 429 - ARINC 629.

#### Unit 3

Cockpit instruments - Flightdeck UI - GNC - Sensors - SMS - Data communications - Spectrum Warfare.

#### Text book(s)

Moir I. and Allan G Seabridge A. G., “Civil Avionics Systems”, Professional Engineering Publishing Limited (London), 2003.

Helfrick A., “Principles of Avionics, Airline Avionics”, 4 ed., Avionics Communications Inc., 2007.

#### Reference(s)

Clifford M., “Aeronautical Engineer's Data Book”, Butterworth-Heinemann (Oxford), 2002.

Spitzer C. R., “The Avionics Handbook”, CRC Press LLC, 2001.

### Evaluation Pattern

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Nil

### Course Objectives

- To understand the radiation concepts for antenna systems
- To design, develop and analyze specific antenna and array systems for various applications
- To motivate for pursuing project and research in the antenna domain

### Course Outcomes

**CO1:** Design and analyze various types of antenna systems and study using electromagnetic simulation

**CO2:** Provide end-to-end solutions in the antenna design aspects and able to choose the suitable configurations

**CO3:** Apply the design and analysis aspects of antennas in research and support the industrial requirements

**CO4:** Ability to provide solutions for wireless connectivity in the RF front-end domain

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 3    |
| CO2    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 3    |
| CO3    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | 3    | 3    | 3    |
| CO4    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 3    | 3    | 3    |

### Syllabus

#### Unit 1

Review of radiation concepts from electromagnetic theory - near and far field - power density Antenna parameters - wire antennas - dipole and monopole - printed dipole - helical antenna - microstrip rectangular and annular ring antenna.

#### Unit 2

Feed techniques - feed systems for circular polarization - Axial ratio - Bandwidth enhancement - Case studies on antenna design for selected applications and electromagnetic simulation studies.

#### Unit 3

Design of Array antenna systems - Principle of array operation - array factor - radiation pattern analysis - side-lobe suppression techniques - element spacing - gain computation - microstrip array - helical array - feed techniques - impedance matching planar feed techniques - corporate feed techniques - multi-layer antenna array and feed systems - Electromagnetic simulations of array antenna systems.

#### Text book(s)

Constantine A. Balanis, "Antenna Theory: Analysis and Design", 4th Edition, Wiley and Sons, ISBN: 978-1-118-64206-1 February 2016.

R James and P S Hall, "Microstrip Antenna: Theory and Design", Peter Peregrinus Ltd, 1986.

**Reference(s)**

Hubregt J Visser, "Antenna Theory and Applications", Wiley.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Nil

### Course Objectives

- To study the planar transmission lines characteristics
- Analysis of general properties of three and four port networks and then design of common types of dividers, couplers and hybrids
- To study the planar microstrip filter theory and design with the frequency characteristics

### Course Outcomes

**CO1:** Able to understand the concepts of planar transmission line characteristics

**CO2:** Able to analyze the effective dielectric constant and characteristics impedance of different types of planar transmission line

**CO3:** Able to understand the properties of passive microwave components used for power division / combining.

**CO4:** Able to design planar microwave circuit

### CO/PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO2    | 3   | 2   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO3    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO4    | 3   | 2   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |

### Syllabus

#### Unit 1

Introduction to planar transmission lines -Stripline – Microstrip line – Suspended stripline – Impedance – Effect of thickness – Attenuation – Applications –Distributed and lumped elements – Terminations – Resonators.

#### Unit 2

Power dividers and Directional couplers - Properties of Dividers and Couplers – Lossless divider – Resistive divider – Wilkinson divider – Directional couplers – Quadrature couplers – Ferrite devices – Circulators – Isolators – Attenuators – Non-ferrite non reciprocal devices.

#### Unit 3

Microwave Filters –Periodic structures – Image parameter method – Insertion loss method – Impedance and frequency scaling – Filter implementation – Stepped impedance filter – Coupled line filter.

#### Text book(s)

David M. Pozar, “Microwave Engineering”, Wiley India Limited, Third Edition, 2007.

Leo G. Maloratsky, “Passive RF& Microwave Integrated Circuits”, Elsevier Inc, First Edition, 2006.

**Reference(s)**

Samuel. Y. Liao, "Microwave Devices and Circuits", Pearson Education, Third Edition, 2004.

David K.Cheng, "Field and Wave Electromagnetics", Pearson Education, Second Edition, 2002.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**PreRequisite(s):** Communication Theory

### Course Objectives

- To provide an overview of the satellite communication systems
- To understand design parameters involved in the communication using satellites
- To appreciate the contribution of satellite communication to the technological advancement in the area of communication

### Course Outcomes

**CO1:** Able to understand the orbital mechanics, various functional principles and prepare link budget for satellite communication systems

**CO2:** Able to comprehend the various subsystems involved in satellite communication and its functionalities

**CO3:** Able to analyze signal processing schemes for satellite communications

**CO4:** Able to understand the application of satellite communication systems

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | 2    | -    | 3    | -    |
| CO2    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | -    |
| CO3    | 3   | 2   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO4    | 3   | 2   | 2   | -   | -   | 3   | -   | -   | -   | -    | 2    | 3    | 3    | -    |

### Syllabus

#### Unit 1

Review of Microwave Communications - Overview of satellite communications - Satellite orbits – Orbital mechanics and effects - Kepler’s laws - Configurations of various orbits - Orbital elements - Elevation and azimuth angles - Doppler effect - Effect of the sun and moon - Sun transit outage. Satellite link models and design – Satellite system parameters - Link budget design.

#### Unit 2

Satellite subsystems – AOCS - TTC&M - Power and communication subsystems - Computations and controlling by processors - Satellite multiple access schemes – FDMA - TDMA and CDMA - Spread spectrum concepts – Comparison of multiple access schemes.

#### Unit 3

Satellite applications – VSAT - DTH television principles - Direct broadcast radios - Principles of navigation – GPS - Satellites and launch vehicles – INSAT - IRS satellites – PSLVs – GSLVs.

#### Text book(s)

*T.Pratt, C.W.Bostain and J.E.Allnut, “Satellite Communications”, John Wiley and Sons, Second Edition, 2003.*  
*Dennis Roddy, “Satellite Communications”, McGraw-Hill Publishing company, Fourth Edition, 2006.*

**Reference(s)**

*Wilbur L.Pritchard, Hendri G. Suyderhoud, Robert A. Nelson, "Satellite Communication Systems Engineering", Prentice Hall/Pearson, 2007.*

*M.Richharia, "Satellite Communication Systems-Design Principles", Macmillan 2003.*

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**PreRequisite(s):** Signal Processing

### Course Objectives

- To introduce the mathematical basics of speech modelling, and its applications
- To help understand the various applications of speech modelling
- To understand the components for developing a natural language processing system
- To comprehend the computational concepts learned in the lecture classes through numerical simulations and programming

### Course Outcomes

**CO1:** Able to understand the mathematical methods required for speech modelling

**CO2:** Able to understand the various applications of speech modelling theory

**CO3:** Able to understand the selected machine learning algorithms used in spoken language processing

**CO4:** Able to carry out implementation of selected speech modelling algorithms, and understand the characteristics of the different types of speech signals

**CO5 :** Develop an insight into the working of the machine learning algorithms used in spoken language processing

### CO-PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | -    |
| CO2    | 2   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 2    | -    |
| CO3    | 3   | 3   | -   | 3   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | 3    |
| CO4    | 3   | 2   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | 3    |
| CO5    | 3   | 2   | 3   | -   | 3   | -   | -   | -   | -   | -    | -    | 3    | 3    | 3    |

### Syllabus

#### Unit 1

Speech analysis - source filter modeling - Speech sounds - Lip radiation - Linear prediction - Lattice filters – Levinson-Durbin recursion. Feature extraction for speech processing - Short term Fourier transform – Mel frequency cepstral coefficients (MFCC) - Perceptual linear prediction (PLP) - Mel filter bank energies.

#### Unit 2

Principles of speech coding - Main characteristics of a speech coder - Key components of a speech coder – From predictive coding to CELP - Improved CELP coders - Wide band speech coding - Audio-visual speech coding -Speech synthesis - Linguistic processing - Acoustic processing - Training models automatically - Text pre-processing - Grapheme to phoneme conversion – Rule based and decision tree approaches - Syntactic prosodic analysis - Prosodic analysis - Speech signal modeling – Introduction to text to speech synthesis (TTS) - popular techniques used in TTS.

#### Unit 3

Principles of speech recognition - Hidden Markov models (HMM) for acoustic modeling - Observation probability and model parameters - HMM as probabilistic automata - Viterbi algorithm - Language models - n-gram language modelling and difficulties with the evaluation of higher order n-grams and solutions. Spoken keyword spotting approaches - Evaluation metric - Spoken language identification – Approaches – Acoustic –



Phonotactic - LVCSR based. Introduction to speaker recognition – popular approaches – introduction to speech understanding – challenges ahead in developing state-of-the-art natural language processing systems.

**Text book(s)**

Joseph Mariani (Ed), “Spoken Language Processing”, John Wiley & Sons, 2009.

Xuedong Huang, Alex Acero, Hsiao-Wuen Hon, “Spoken Language Processing, A guide to theory, algorithm and system development”, Prentice Hall, Inc, New Joursey, USA, 2001.

**Reference(s)**

J Benesty, M MSondhi, Y. Huang (Eds.), “Springer Handbook on Speech Processing”, Springer-Verlag Berlin, Heidenberg, 2008.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Signal Processing

**Course Objectives**

- To introduce the signal models used in radar signal processing
- To familiarize the different signal processing concepts and wave form design
- To implement and analyze signal processing aspects of radar

**Course Outcomes**

**CO1:** Able to understand the signal processing techniques and applying it to practical problems

**CO2:** Able to develop signal models and analyze real time systems

**CO3:** Able to generate and model mathematically the radar wave forms and performs the analysis

**CO4:** Able to apply the signal processing techniques to different radar systems

**CO – PO Mapping**

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | 2    |
| CO2    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | 2    |
| CO3    | 3   | 3   | -   | 3   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | 2    |
| CO4    | 3   | 2   | 3   | 3   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | 2    |

**Syllabus**

**Unit 1**

Review of selected signal processing concepts and operations for radar - Sampling in radar signals - fast time - slow

Time - Doppler spectrum, spatial and angle dimensions – Quantization.

**Unit 2**

Signal Model - Amplitude models – Clutter - Frequency models - spatial models - spectral model - and noise model and signal to noise ratio – Waveforms - Pulse burst waveform - frequency modulated pulse compression waveforms.

**Unit 3**

MIMO radar and Phased array radar - Beamforming and space time adaptive processing - Conventional Beamforming - adaptive beamforming - Space time signal environment - Processing space time signal model.

**Text book(s)**

Mark A.Richards, “Fundamentals of Radar signal Processing”, Tata McGraw-Hill edition, Tata McGraw-Hill education pvt Ltd. 2005.

Merill I Skolink, “Introduction to radar systems”, Third edition. McGraw Hill Education(India)Edition,2001.

**Reference(s)**

*Bassem r Mahafza, "Radar System Analysis and design using Matlab", Third edition, CRC Press, 2015.*  
*Jian Li, PetreStoica, "MIMO Radar Signal Processing", First Edition, John Wiley & Sons Inc, 2009.*

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**PreRequisite(s):**Signal Processing

### Course Objectives

- To enable the students to understand discrete-time random process and fundamentals of signal models
- To enable the students to understand optimum linear filtering and adaptive filtering
- To enable the students to understand the various estimation methods

### Course Outcomes

**CO1:** Able to understand discrete-time random processes and various signal models and hence apply it to real time problems

**CO2:** Able to analyse and develop algorithms for linear filtering, steepest descent, Least Mean Square (LMS), and Recursive Least Squares (RLS) adaptive filter algorithms

**CO3:** Able to understand the spectral estimators and hence be able to analyse the different types and hence design solution for estimation problems

**CO4:** Able to formulate and apply frequency estimation algorithms

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 1   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | 3    | 1    | 1    |
| CO2    | 3   | 3   | 1   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 1    |
| CO3    | 3   | 3   | 3   | 2   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 3    |
| CO4    | 3   | 3   | 3   | 2   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 3    |

### Syllabus

#### Unit 1

Random processes - Gaussian Processes- Stationary processes -Autocovariance and Autocorrelation matricesErgodicity - White noise - Power spectrum - Autoregressive moving average processes - Signal Modeling - The Least Squares method – Autocorrelation method –Covariance method - Autoregressive moving average models.

#### Unit 2

Levinson-Durbin Recursion - Lattice filters - FIR Lattice filter - IIR Lattice filter - Wiener filtering - FIR Wiener filter-IIR Wiener filter - Adaptive filtering - FIR adaptive filters-Steepest Descent adaptive filter - LMS algorithm - Gradient adaptive lattice filter - Adaptive Recursive filters- Recursive Least squares.

#### Unit 3

Spectrum Estimation - Nonparametric methods –Periodogram - Barlett's method - Welch's method - Blackman and

Tukey - method of smoothing periodogram - Parametric methods - Autoregressive spectrum estimation - Moving average spectrum estimation - Frequency estimation - Eigen decomposition of Autocorrelation matrix - Detection of

Harmonic signals -Pisarenko's method - MUSIC algorithm.

**Text book(s)**

M.H. Hayes, "Statistical Digital Signal Processing and Modelling", John Wiley, 1996.  
P.Stroica&R.Moses, "Spectral Analysis of signals", Prentice hall, 2005.

**Reference(s)**

Steven M. Kay, "Fundamentals of Statistical Signal Processing: Vol. 1: Estimation Theory, Vol. 2: Detection Theory", Pearson, 2009.  
Louis Scharf, "Statistical Signal Processing", Pearson, 2010.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Signal Processing

### Course Objectives

- To introduce the fundamental concepts and techniques in basic digital image processing
- To familiarize mathematical transforms necessary for image processing
- To get sufficient expertise in both the theory of two-dimensional signal processing and its wide range of applications such as image enhancement, image compression, and image segmentation
- To apply various image processing algorithms to solve problems in different domains

### Course Outcomes

**CO1:** Able to analyze the necessity for various image transforms and their properties

**CO2:** Able to understand the different techniques adapted for image enhancement in spatial and frequency domain

**CO3:** Able to evaluate the image compression techniques in spatial and frequency domain

**CO4:** Able to pursue research in image analysis and applications

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 2   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 2    | -    |
| CO2    | 2   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 2    | -    |
| CO3    | 2   | 3   | 3   | 2   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | 2    |
| CO4    | 3   | 2   | 3   | 2   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | 3    |

### Syllabus

#### Unit 1

Digitization & Sampling - Elements of visual perception Brightness & contrast - Image sensing & Acquisition-Image sampling & Quantization-some basic relationships between pixels - Distance measures - 2-D transforms and Properties - Image Enhancement in spatial and frequency domain -smoothing spatial filters-sharpening spatial Filters-Review of sampling and discrete Fourier Transform - Homomorphic filtering.

#### Unit 2

Image analysis – applications - Spatial and transform features - Edge detection - boundary extraction - AR models and region representation - Moments as features - Image structure - Morphological operations and transforms –Texture - Scene matching and detection - Segmentation and classification.

#### Unit 3

Image data compression- sub sampling - Coarse quantization and frame repetition - Pixel coding - PCM - entropy coding - run length coding Bit-plane coding - Predictive coding - Transform coding of images - Hybrid coding and vector DPCM - Inter frame hybrid coding.

#### Text book(s)

Rafael C Gonzalez and Richard E Woods, “Digital Image Processing”, Pearson Education, New Delhi, 2009.  
Anil K Jain, “Fundamentals of Digital Image Processing”, Prentice Hall of India, New Delhi, 2010.

**Reference(s)**

William K Pratt, "Digital Image Processing", Wiley, 2010.

John W. Woods, "Multidimensional Signal, Image, and Video Processing and Coding", Academic Publisher, 2012.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Signal Processing

### Course Objectives

- To introduce origin and characteristics of biomedical signals
- To provide an understanding on the application of signal processing concepts in analyzing biomedical signals
- To implement algorithms for various biomedical signal processing tasks

### Course Outcomes

**CO1:** Able to understand techniques for various levels of tasks in biomedical signal analysis

**CO2:** Able to adopt appropriate algorithms according to nature of the signal and acquisition characteristics

**CO3:** Able to develop contemporary algorithms to address complex problems

**CO4:** Able to implement biomedical signal processing algorithms using appropriate tools

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 2   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 2    | -    |
| CO2    | 2   | 3   | 2   | 2   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | 2    |
| CO3    | 2   | -   | 3   | 3   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 3    |
| CO4    | 2   | -   | -   | -   | -   | -   | -   | 2   | -   | -    | -    | -    | 2    | 2    |

### Syllabus

#### Unit 1

Review of Signal Processing – LTI systems – Convolution – Transform Analysis – Fourier Spectrum – Power Spectral Density – Time and Frequency Domain filters – Introduction to Biomedical signals – Origin and Characteristics.

#### Unit 2

Filtering for Removal of Artifacts in ECG – Algorithms for QRS Detection – Morphological Analysis of ECG Waves– EEG Rhythms, Waves and Transients – Correlation Analysis of EEG Channels.

#### Unit 3

Image Artifact Removal – Mask Processing – Contrast Enhancement – Histogram Equalization – Histogram Matching – Detection of Regions of Interest – Thresholding– Region Growing – Application in Selected Biomedical Images.

#### Text book(s)

*Oppenheim A V, Schafer R W and Buck J R, “Discrete-Time Signal Processing”, Third Edition, Prentice Hall, 2009.*

*Rangayyan R M, “Biomedical Signal Analysis-A Case- Study Approach”, Second Edition, Wiley -IEEE Press 2015.*

#### Reference(s)

*Kay S M, “Fundamentals of Statistical Signal Processing; Practical Algorithm Development”, Vol . III, Prentice Hall, 2013.*

*Begg R, Palaniswami M and Lai D T H, “Computational Intelligence in Biomedical Engineering”, CRC Press, 2007.*



### Evaluation Pattern

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Signal Processing

### Course Objectives

- To introduce the acquisition of hyperspectral imaging using various sensors
- To provide the students with concepts, methodologies and applications of hyper spectral Imaging technology
- To address the challenges of hyper spectral imaging in various fields

### Course Outcomes

**CO1:** Able to understand various hyperspectral image acquisition techniques

**CO2:** Able to analyze the pre-processing techniques used for hyperspectral image analysis

**CO3:** Able to apply the machine learning algorithms used for hyperspectral image classification

**CO4:** Able to implement the pre-processing and classification techniques for various applications

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | -   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO2    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | -    |
| CO3    | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | -    |
| CO4    | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |

### Syllabus

#### Unit 1

Hyperspectral Imaging - Background and Equipment - Digital Images - Multivariate images and hyperspectral images - Study of hyperspectral sensors- Hyperspectral image generation – Essentials of hyperspectral image analysis - Principles of hyperspectral Image Analysis in remote sensing - Technology and industry - Pre-processing of hyper spectral imagery - atmospheric calibration/correction - spectral correlation and data redundancy -dimensionality reduction and feature selection - end member extraction.

#### Unit 2

Clustering and classification in hyperspectral Imaging - Supervised and unsupervised classification of hyperspectral Imaging – Visualization and colouring of segmented images and graphs- Hyperspectral image data conditioning and regression analysis – Principles of image cross validation – Detection - Classification and quantification in hyperspectral imaging – Resolution and calibration in hyperspectral images.

#### Unit 3

Applications of hyper spectral remote sensing - vegetation biophysical and biochemical parameters - soil properties - mineral identification - water quality assessment - material identification and mapping - anomaly detection - reference spectral libraries – USGS - and ASTER spectral libraries.

#### Text book(s)

*Hans F. Grahn and Paul Geladi, "Techniques and Applications of Hyperspectral Image Analysis", First Edition, John Wiley & Sons, Ltd, 2007.*

*Wang. L and Zhao. C, "Hyperspectral Image Processing", First Edition, Springer, 2016.*

**Reference(s)**

Marcus Borengasser, William S. Hungate, and Russell Watkins, "Hyper spectral Remote Sensing: Principles and Applications", First Edition, CRC Press, 2007.

Pramod K. Varshney and Manoj K. Arora, "Advanced Image Processing Techniques for Remotely Sensed Hyperspectral Data", First Edition, Springer-Verlag Berlin Heidelberg, 2004.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**PreRequisite(s):**SignalProcessing

### Course Objectives

- To understand the analysis, design and applications of filter banks
- To analyze the conditions to be satisfied for scaling and wavelet function to be a wavelet
- To design wavelets and understanding different types of wavelets

### Course Outcomes

**CO1:** Able to understand the design and application of filter banks

**CO2:** Able to analyze the properties of wavelets

**CO3:** Able to design Wavelets and analysis on different types of wavelet

**CO4:** Able to apply wavelets for various applications

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |
| CO2    | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |
| CO3    | 2   | 3   | 3   | 2   | -   | -   | -   | -   | -   | -    | -    | -    | -    | 2    |
| CO4    | 2   | 2   | -   | 2   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |

### Syllabus

#### Unit 1

Introduction to wavelets-Vector Space-Functions and function spaces- Continuous time Fourier Transforms-Short time Fourier transforms-The uncertainty principle and time-frequency tiling-Discrete wavelet transforms-Scaling and Wavelet Functions – Filter Banks.

#### Unit 2

Legendre Polynomials – Recurrence Formula – Laplace’s Integral Formula – Design of Orthogonal Wavelet Systems – Bi-orthogonal Wavelet – Introduction to Lifting Scheme – Dealing with Signal Boundaries – Multi Wavelet – Frequency Domain Approach – Design of Wavelet.

#### Unit 3

Wavelet in Image Processing – Biomedical Applications – Data Compression – EZW Algorithm – De-noising – Edge Detection – Object Isolation – Audio Coding – Communication Applications – Channel Coding – Speckle Removal – Image Fusion–Filter Design – Signal Analysis – Image Compression– PDEs –Wavelet Transforms on Complex Geometrical Shapes.

#### Text book(s)

Soman K. P. and Ramachandran K. I., “Insight into Wavelets from Theory to Practice”, Prentice Hall, third edition, 2010.

Stéphane Mallat, “A Wavelet Tour of Signal Processing: The Sparse Way”, Academic Press Elsevier 2009.

#### Reference(s)

Howard L. Resnikoff and Raymond O. Wells, “Wavelets Analysis the Scalable Structure of Information”, Springer, 1998.

Strang G. and Nguyen T. Q., “Wavelets and Filter Banks”, Wellesley Cambridge Press, 1998.

### Evaluation Pattern

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**PreRequisite(s):**Signal Processing

### Course Objectives

- To introduce the adaptive filter for estimation and tracking
- To develop various adaptive algorithms for communication systems.
- To apply the adaptive theory to a variety of practical problems

### Course Outcomes

**CO1:** Able to analyze the filtering tasks and identify the need for adaptation in filtering

**CO2:** Able to design filter to meet performance requirements derived from various real life applications

**CO3:** Able to develop algorithms for the design of filters to track variations of non-stationary random process

**CO4:** Able to evaluate the performance of the developed filter in terms of computational complexity, convergence time and stability

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 2   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |
| CO2    | 2   | 2   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |
| CO3    | 2   | 3   | 3   | 2   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | 2    |
| CO4    | 3   | 2   | 3   | 2   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | 2    |

### Syllabus

#### Unit 1

Discrete time stochastic processes - Re-visiting probability and random variables - Discrete time random processes- Power spectral density – properties- Autocorrelation and covariance structures of discrete time random processes-Eigen-analysis of autocorrelation matrices - Spectrum Estimation - Non-parametric methods - Estimators and its performance analysis -periodogram estimators - signal modeling - parameter estimation using Yule- Walker Method.

#### Unit 2

LMS Algorithm - Need for adaptive filtering - Wiener FIR adaptive filters – Newton’s method - Steepest descent method –Convergence analysis - Performance surface – Least Mean Square (LMS) adaption algorithms– Convergence – Excess mean square error –Leaky LMS - Normalized LMS – Block LMS Least Squares Algorithm -Recursive least squares (RLS) algorithm for adaptive filtering of stationary process- Matrix inversion – Comparison with LMS – RLS for quasi-stationary signals- Exponentially weighted RLS- Sliding window RLS – RLS algorithm for array processing – Adaptive beam forming – Other applications of adaptive filters – Echo cancellation – Channel Equalization.

#### Unit 3

Kalman Filtering - Statistical filtering for non-stationary signals – Kalman filtering- Principles – Initialization and tracking – Scalar and vector Kalman filter – Applications in signal processing – Time varying channel estimation – Radar tracking.

**Text book(s)**

Simon O. Haykin, "Adaptive Filter Theory", 5 th Edition, Pearson Education Limited, 2014.

Dimitris G. Manolakis, Vinay K. Ingle, Stephen M. Kogon, "Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering, and Array Processing", McGraw-Hill, 2005.

**Reference(s)**

Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons, Inc., Singapore, 2002.

Sopocles J. Orfanidis, "Optimum Signal Processing", McGraw Hill, 2007.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

## Computer Science Engineering

19CSE471

PRINCIPLES OF OPERATING SYSTEMS

L-T-P-C: 3-0-0-3

**Pre Requisite(s):** Nil

### Course Objectives

- To understand the structure and implementation of modern operating systems, virtual machines and their applications
- To summarize techniques for achieving process synchronization and managing resources like memory and CPU in an operation system
- To compare and contrast the common algorithms used for both pre-emptive and non-pre-emptive scheduling of tasks in operating systems (such a priority, performance comparison, and fair-share schemes)
- To give a broad overview of memory hierarchy and the schemes used by the operating systems to manage storage requirements efficiently

### Course Outcomes

**CO1:** To understand the architecture and functionalities of modern Operating System

**CO2:** To understand and apply the algorithms for scheduling

**CO3:** To understand and apply the algorithms for resource management

**CO4:** To apply semaphores and monitors for classical and real world synchronization scenarios

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 1   | 1   | 1   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | 3    |
| CO2    | 2   | 2   | 3   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | 3    |
| CO 3   | 2   | 2   | 3   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | 3    |
| CO4    | 2   | 3   | 3   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | 3    |

### Syllabus

#### Unit 1

Introduction to operating systems: Overview – hardware protection – operating systems services – system calls – system structure – virtual machines.

#### Unit 2

Process concepts – process scheduling – operations on process – inter-process communication – multi threading models – threading issues – thread types – CPU scheduling. Process synchronization: critical section problem – semaphores – classical problems of synchronization —Deadlocks – deadlock characterization – methods of handling deadlocks – deadlock prevention – avoidance – detection and recovery.

#### Unit 3

Storage management: memory management – swapping – contiguous memory allocation. Paging and segmentation – segmentation with paging – virtual memory – demand paging– page replacement.



**Text Book(s)**

Silberschatz A, Gagne G, Galvin PB. "Operating system concepts", Wiley; 2018.

**Reference(s)**

Deitel. Deitel, Choffnes. "Operating System", Third Edition, Prentice Hall; 2003.

Tanenbaum AS, Bos H. "Modern operating systems", Pearson; 2015.

Stevens WR, Rago SA., "Advanced programming in the UNIX environment", Addison-Wesley; 2008.

Gary Nutt, "Operating Systems", Third Edition, Addison Wesley; 2009.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Nil

### Course Objectives

- This is a hands-on elective course which introduces the fundamentals of native android application development using Android Studio
- The students will learn to customize activities and intents, create rich user interface and manage data on databases such as SQLite
- The course provides exposure to use various components such as services, async tasks, broadcast receivers and content providers
- The students also learn to use various APIs such as Maps, Sensors and GPS enabling them to develop ready to use android applications for real-world use cases

### Course Outcomes

**CO1:**To understand the fundamental concepts of android operating system and android application development

**CO2:**To understand the various building blocks of native android applications

**CO3:**To design android specific user interface (UI)

**CO4:** To design and develop applications using android services and sensors

**CO5:**To understand and apply data storage and sharing techniques for applications

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 2   | -   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 3    |
| CO2    | 2   | 2   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 3    |
| CO3    | 2   | 1   | 1   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 3    |
| CO4    | 2   | 1   | 1   | 3   | -   | -   | -   | 3   | 3   | 3    | -    | 3    | 3    | 3    |
| CO5    | 2   | 2   | 2   | 3   | -   | -   | -   | 3   | 3   | 3    | -    | 3    | 3    | 3    |

### Syllabus

#### Unit 1

Basics of Android - Android OS architecture – Versions – SDK - API Levels - Set up of mobile app development environment - Understand the app idea and design user interface/wireframes of mobile application - Developing and debugging mobile app components - First application - understanding file structure - layout and resource files - deployment - emulators and devices.

Basic UI design - Button, EditText – TextView - basic event handlers - Activity – Lifecycle - Layouts - Selection components – Radio – checkbox - Date/Time Picker – ListView - Grid view – ScrollView - Image view - Image buttons – Spinner – Toggle – Autocomplete TextView

Advanced UI design - Intents - Internal/External/Pending - Intent Filters - Android Manifest - Permissions – Fragment - Fragment Lifecycle - Fragment communication – Menu – Notifications - Material Design - Navigation Drawer – WebView.

#### Unit 2

Data storage - SQLite, SharedPreferences - Internal/External Storage - Room Persistence Library - Background Processing - Services – Started – Bound – Foreground - Intent Service – AsyncTasks - Broadcast receivers - Content Providers - Content resolvers.

### Unit 3

Sensors - Motion sensors – Environmental - Position sensors - Touch sensors and Gesture detector - Location Based Services - GPS and Google Maps - Apps with Connectivity to External APIs.

#### **Text Book(s)**

*Burd B, “Android application development all-in-one for dummies”, John Wiley & Sons; 2015.*

#### **Reference(s)**

*“Android Developer Fundamentals Version2”, 2018, Accessible online :*

*<https://developer.android.com/courses/fundamentals-training/overview-v2>.*

*Darcey L, Conder S. Sams, “Teach Yourself Android Application Development in 24 Hours: Sams Teac Your AndrAppl D\_2”, Pearson Education; 2011.*

*Hardy B, Phillips B., “ Android Programming: The Big Nerd Ranch Guide”, Addison-Wesley Professional; 2013.*

#### **Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Nil

### Course Objectives

- To introduce basic software engineering concepts
- To introduce the Agile Software development process
- Hands on training (experiential learning) to digest the concepts learned in the class. This is a reading and discussion subject on issues in the engineering of software systems and software development project design. It includes the present state of software engineering, what has been tried in the past, what worked, what did not, and why

### Course Outcomes

**CO1:**To understand the fundamentals of cyber-physical systems and analyze their design in different applications

**CO2:**To understand the foundations of modeling in CPSs, software based feedback control and apply them in the context of sample CPS systems

**CO3:**To understand the design of distributed CPS systems with respect to synchronization, real-time scheduling and management and security issues

**CO4:** To understand the techniques for formal verification and model integration in CPS and apply them in different domain applications

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 1   | -   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | 2    |
| CO2    | 2   | 3   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | 2    |
| CO3    | 2   | 1   | 3   | -   | -   | 2   | -   | -   | -   | 1    | -    | 2    | 3    | 2    |
| CO4    | 2   | 2   | 2   | -   | -   | 3   | -   | -   | -   | 3    | -    | 2    | 3    | 2    |
| CO5    | -   | -   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | 2    |

### Syllabus

#### Unit 1

Process Models – overview - Introduction to Agile - Agile Manifesto - principles of agile manifesto - Agile Requirements - User personas - story mapping - user stories - estimating and prioritizing stories – INVEST - acceptance criteria - Definition of Done - Release planning - Key aspects of Scrum - roles - Product Owner - Scrum Master - Team and product backlog Scrum process flow - product backlog - sprints backlog - scrum meetings –demos - How sprint works - Sprint Planning - Daily scrum meeting - updating sprint backlog - Burn down chart - sprint review - sprint retrospective - Scrum Metrics – velocity - burn down - defects carried over.

#### Unit 2

Traditional process Models – Waterfall – incremental - Requirements Engineering - Tasks Initiation – Elicitation- Developing Use Cases-Building the analysis Model – Negotiation – Validation - Requirements Modelling - building the analysis model - Scenario based methods - UML Models.

#### Unit 3

Design engineering Design concepts - Design models - software architecture - architectural styles and patterns - Performing user interface Design-Golden Rules-User Interface Analysis and Design- Interface Analysis-Interface design steps - Testing strategies and tactics - Unit testing - integration testing - validation and system testing.

**Text Book(s)**

Pressman R S, Bruce R. Maxim, "Software engineering - A Practitioner's Approach", Eighth Edition, Tata McGraw-Hill, 2014.

**Reference(s)**

Crowder JA, Friess S, "Agile project management: managing for success", Cham: Springer International Publishing; 2015.

Stellman A, Greene J. Learning agil, "Understanding scrum, XP, lean, and kanban", O'Reilly Media, Inc. "; 2014.  
Gregory J, Crispin L., "More agile testing: learning journeys for the whole team", Addison-Wesley Professional; 2014.

Rubin KS., "Essential Scrum: a practical guide to the most popular agile process", Addison-Wesley; 2012.

Cohn M. User stories applied: For agile software development. Addison-Wesley Professional; 2004.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Object Oriented Paradigm, Embedded Systems, Discrete Mathematics

### Course Objectives

- The aim of this course is to provide an introduction to big data technologies and tools used for big data
- Basics of relational databases and its implementation strategy using SQL are discussed in the first phase
- The second phase discusses on concepts big data and its architecture, storage and processing of data in parallel and distributed system
- In the last phase retrieval and analysis of unstructured data are done using NOSQL databases

### Course Outcomes

**CO1:** Understand fundamental concepts of Databases and SQL

**CO2:** Apply SQL for data storage and retrieval

**CO3:** Understand fundamental concepts of Big Data and its technologies

**CO4:** Apply Map reduce programming for big data

**CO5:** Analyze appropriate NoSQL database techniques for storing and processing large volumes of structured and unstructured data

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 2   | 1   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO2    | 1   | 3   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO3    | -   | 2   | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO4    | -   | 3   | 2   | 2   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO5    | -   | -   | -   | 2   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |

### Syllabus

#### Unit 1

Introduction - Overview of DBMS - File vs DBMS - elements of DBMS - Relational Data Model - Introduction to relational model - Structure of relational mode – domain – keys - tuples to relational models - SQL – table creation - relationships - basic queries DML and DDL – Joins– Grouping.

#### Unit 2

Introduction to Big Data - Types of Digital Data - Characteristics of Data – Evolution of Big Data - Definition of Big Data - Challenges with Big Data-3Vs of Big Data -Terminologies in Big Data - CAP Theorem - BASE Concept – NoSQL - Types of Databases – Advantages – NewSQL - SQL vs. NOSQL vsNewSQL - Introduction to Hadoop - Features – Advantages – Versions - Overview of Hadoop Eco systems - Hadoop distributions - Hadoop vs. SQL – RDBMS vs. Hadoop - Hadoop Components – Architecture – HDFS - Map Reduce: Mapper – Reducer - Map Reduce - Mapper – Reducer – Combiner – Partitioner - Hadoop 2 (YARN) - Architecture - Interacting with Hadoop Eco systems.

#### Unit 3

No SQL databases - Cassandra: Introduction – Features - Data types – CQLSH - Key spaces - CRUD operations – Collections – Counter – TTL - Alter commands - Import and Export - Querying System tables.

**Text Book(s)**

Seema Acharya, Subhashini Chellappa, "Big Data and Analytics", Wiley Publication, 2015.

**Reference(s)**

Hurwitz JS, Nugent A, Halper F, Kaufman M. "Big data for dummies", John Wiley & Sons; 2013.

White T., "Hadoop: The definitive guide". O'Reilly Media, Inc.; 2012.

Bradberry R, Lubow E., "Practical Cassandra: a developer's approach", Addison-Wesley; 2013.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Nil

### Course Objectives

- This course covers the basic concepts in computer science and engineering but not limited to object oriented programming, database design and software engineering that aids the students of non-CSE to develop applications to solve real world problems

### Course Outcomes

**CO1:** Understand and Apply the fundamental concepts of Computer System and Computer Programming

**CO2:** Apply Object Oriented Paradigm

**CO3:** Design Relational Database Management system for a scenario

**CO4:** Understand and Apply Software Engineering Principles

**CO5:** Apply OOAD principles, Design UML and understand Testing Tools

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 2   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO2    | 2   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO3    | 2   | 2   | -   | 2   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | 2    |
| CO4    | 2   | 1   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | 2    |
| CO5    | 2   | 1   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | 2    |

### Syllabus

#### Unit 1

An Overview of the Computer System-The Parts of a Computer System - Operating System – Input - Output and storage devices - Basics of Networking - Types of Networks and Topology -Introduction to Programming using Scratch and Flowgorithm - Introduction to Object Oriented Paradigm – Abstraction - Encapsulation and Data Hiding - Classes and Objects – Methods - Inheritance and Polymorphism - Introduction to Python programming - Python data variables and operators -Control Structures – Strings - Functions – Built-in functions - User-defined functions and Recursion - Data Structures – List.

#### Unit 2

Database fundamentals - Data and Need for DBMS - Relational Model and Keys - Data representation and keys in RDBMS - Logical database Design - ER Modeling and notations - Physical Database Design - Converting ER model to Relational Schema – Normalization - Introduction – 1NF- 2NF - 3NF - Implementation with SQL – Introduction -Data types and operators in SQL - SQL statements - Built-in Functions - Group-By and CSE clause - Joins and sub queries - Transaction Management - ACID properties.

#### Unit 3

Introduction to Software Engineering - UML Diagrams - Object Oriented Analysis and Design - Role of UML in Object Oriented Analysis and Design - UML Building blocks - Structural Things – Behavioral - Grouping and Annotational. Relationships – Dependency - Association - generalization and Realization – UML - Class diagrams -Testing strategies.



**Text Book(s)**

Electronic Resources at <http://campusconnect.infosys.com/>.

Phillips D. "Python 3 Object Oriented Programming", Packt Publishing Ltd; 2010.

Swaroop C H., "A Byte of Python", ebsshelfInc; 2013.

Silberschatz A, Korth HF, Sudarshan S., "System Concepts", 2010.

Pressman RS., "Software engineering: a practitioner's approach", Palgrave Macmillan; 2014.

**Reference(s)**

<https://www.coursera.org/#course/cs101>.

<https://www.udacity.com/course/viewer#!c-cs215/l-48747095/m-48691607>.

<http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-830-database-systems-fall-2010/lecture-notes/>.

<http://nptel.ac.in/courses.php>.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Nil

### Course Objectives

- The Database Management Systems (DBMS) has become a core component of the systems solving real world engineering problems in all the disciplines. Hence, knowledge about database systems has become an essential part of an education in engineering
- This course presents the concepts of database, database design, normalization, database-system implementation and maintenance

### Course Outcomes

**CO1:** Understanding the purpose and architecture of DBMS

**CO2:** Design of relational databases and writing SQL and PL/SQL statements to query relational databases

**CO3:** Design and build ER models for sample databases

**CO4:** Design and build a normalized database management system for real world databases

**CO5:** Understand the principles of transaction processing and concurrency control

### CO – PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 1   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO2    | 3   | 2   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO3    | 3   | 2   | 3   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO4    | 3   | 2   | 3   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |

### Syllabus

#### Unit I

Introduction - History of database systems - Purpose of Database systems – File Systems Vs Database systems – Database architecture – Different Data models of Database - Relational Data Model - Structure of relational databases – Database schema – Formal Relational Query Languages - Database Design - Overview of the design process - The E-R Models – Constraints - Removing Redundant Attributes in Entity Sets - E-R Diagrams - Reduction to Relational Schemas.

#### Unit 2

Relational Database Design - Different Normal forms - 1NF - 2NF - 3NF - BCNF and Higher Normal Forms - Decomposition using Functional Dependencies - Functional Dependency Theory - Multi-valued dependency – SQL - Introduction to SQL – Intermediate SQL.

#### Unit 3

Transactions - Transaction concept – A simple transaction model - Transaction atomicity and durability - Serializability – Recoverable schedules - Cascadeless schedules - Concurrency control - Lock-based protocols – Locks - granting of locks - The two-phase locking protocol - Graph-based protocols - Deadlock handling - Deadlock prevention - Deadlock detection and recovery.

**Text Book(s)**

Silberschatz A, Korth H F, Sudharshan S. "Database System Concepts", Sixth Edition, TMH publishing company limited; 2011.

**Reference(s)**

Dorđević-Kajan S, Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom, "Database system: The complete book", Factauniversitatis-series: Electronics and Energetics; 2003.

Elmasri R, Navathe SB. "Fundamentals of Database systems", 2006.

Ramakrishnan R, Gehrke J. "Database management systems" McGraw Hill; 2000.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):** Nil

**Course Objectives**

- The course provides an insight of data transmission among “n” systems and highlights on the layered approach

**Course Outcomes**

**CO1:** To understand the basic concepts of Networks, and signals

**CO2:** To understand the transmission media and data link layer functionalities

**CO3:** To analyze routing protocol and internetworking concepts

**CO4:** To configure DNS and HTTP servers

**CO-PO Mapping**

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 3   | 2   | -   | 2   | -   | -   | -   | -   | -   | -    | -    |      | 3    | 2    |
| CO2    | 3   | 2   | -   | 2   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | 2    |
| CO3    | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | 2    |
| CO4    | 3   | 2   | 3   | 2   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    | 2    |

**Syllabus**

**Unit 1**

Introduction - Data communications – Networks - The Internet - Protocols and standards - Network Models - layered tasks - TCP/IP protocol suite – Addressing - Data and signals - Analog and digital - data rate limits – performance - Digital transmission - digital – to digital conversion - Analog-to-digital conversion - transmission modes.

**Unit 2**

Transmission media - guided media – unguided media (wireless) - Switching - Circuit switched networks - datagram networks - virtual circuit networks - structure of a switch - Data link layer - Error detection and corrections Introduction - block coding - linear block codes - cyclic codes – checksum - Data link control – Framing - flow and error control – protocols - noiseless channels - noisy channel - Multiple Access - Random access - Controlled access – Channelization - Wired LANs – Ethernet - IEEE standards - Standard Ethernet - changes in the standard - Fast Ethernet - Gigabit Ethernet.

**Unit 3**

Network layer - IPv4 Addresses - IPv6 Addresses - Internet Protocols – Internetworking - IPv4 - IPv6 - transition from IPv4 to IPv6 - Transport Layer - process- to – process delivery - user datagram protocol – TCP - Overview of DNS and overview of HTTP.

**Text Book(s)**

Forouzan AB, “Data communications & networking (sie)”, Tata McGraw-Hill Education, 2007.

**Reference(s)**

Stallings W. “Data and computer communications”, Pearson Education India, 2007.

Douglas E. Comer. “Internet working with TCP/IP Volume -1”, Sixth Edition, Addison-Wesley Professional, 2013.

### Evaluation Pattern

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):**Computer Programming

### Course Objectives

- This course focuses on learning Python and C++
- The course also emphasizes on ADT and STL usage for implementing data structures
- The course participants are expected to have basic skills in these languages

### Course Outcomes

- CO 1:** Understand the static object oriented programming concepts and thereby to understand a given program  
**CO 2:** Understand the dynamic object oriented programming concepts and thereby to understand a given program  
**CO 3:** Implement ADT in static and dynamic object oriented paradigm  
**CO 4:** Analyze the similarities, differences and code efficiency among object oriented programming languages  
**CO 5:** Develop computer programs that implement suitable algorithms for given problem scenario and applications

### CO-PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1    | 1   | -   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO2    | 1   | -   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO3    | 2   | 3   | 2   | -   | -   | -   | -   | 2   | -   | -    | -    | -    | 3    | 2    |
| CO4    | 1   | 2   | 2   | -   | -   | -   | -   | 2   | -   | -    | -    | -    | 3    | 2    |
| CO5    | 2   | 3   | 2   | -   | -   | -   | -   | 3   | -   | -    | -    | -    | 3    | 2    |

### Syllabus

#### Unit 1

Overview of Object Oriented Paradigm - Programming in C++ - Objects as a group of variables - Classes as a named group of methods and data - Morphing from structures to classes - Input and Output - Access Specifiers - Member functions – Accessor - Mutator and Auxiliary - Constructors and Destructors - New and Delete Operators – Overloading – Inheritance - Handling Access and Specialization through Overriding – Polymorphism - Virtual Functions - Abstract Class and Virtual Function Tables.

#### Unit 2

Revisiting Pointers - Pointers to Pointers - Pointers and String Array - Void Pointers and Function Pointers - Standard Template Library - Implementation of Stack – Queue - Hash Table and Linked Lists with STL. Basic Python - Multi-paradigm language - Data Types and Variables – Indentation - Input and Output statements - Lists and Strings -Deep and Shallow Copy - Tuples and Dictionaries - Set and Frozen Sets - Control Statements and Loops - Iterators and Iterable – Functions -Recursion and Parameter Passing - Namespaces and Variable Scope - Exception Handling.

#### Unit 3

Object Oriented Concepts in Python – Class - Instance Attributes – Getters – Setters – Inheritance - Multiple Inheritance - Magic Methods and Operator Overloading - Class Creation – Slots - Meta Classes and Abstract Classes - Implementation of Stack – Queue - Hash Table and Linked Lists.

**Text Book(s)**

Stroustrup B., "Programming: principles and practice using C++", Second edition, Addison Wesley, 2014.  
Charles R. Severance. "Python for Everybody: Exploring Data Using Python 3", Charles Severance, 2016.

**Reference(s)**

Gutttag J. "Introduction to Computation and Programming Using Python: With Application to Understanding Data", Second Edition. MIT Press; 2016.

Gaddis T. "Starting Out with Python", Third Edition, Pearson; 2014.

Lambert KA. "Fundamentals of Python: first programs", Second Edition, Cengage Learning; 2018.

Downey AB. "Think Python: How to Think Like a Computer Scientist", O'Reilly Media; 2012.

**Evaluation Pattern**

| Assessment                  | Internal | External |
|-----------------------------|----------|----------|
| Periodical 1 (P1)           | 15       |          |
| Periodical 2 (P2)           | 15       |          |
| *Continuous Assessment (CA) | 20       |          |
| End Semester                |          | 50       |

\*CA – Can be Quizzes, Assignment, Projects, and Reports

**Pre Requisite(s):**Computer Programming

### Course Objectives

- This course aims at equipping the learners to develop Object-Oriented software using the Unified Modelling Language and the Java Programming Language
- This course motivates to think of problem solving in Object-Oriented way using the methods and tools that support this paradigm

### Course Outcomes

**CO 1:** Understand Object Oriented paradigm and represent the problem using objects and classes

**CO 2:** Apply the Object Oriented concepts to design and develop effective models using UML

**CO 3:** Develop programs using Object oriented concepts in Java

**CO 4:** Understanding parallelizing of tasks and synchronization using threads

**CO 5:** Design applications in Java using Java libraries

### CO-PO Mapping

| PO/PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1    | 1   | 2   | 1   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO2    | 3   | 3   | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | 3    | 2    |
| CO3    | 1   | 2   | 3   | -   | -   | -   | -   | 2   | 2   | -    | -    | -    | 3    | 2    |
| CO4    | 1   | 1   | 2   | 2   | -   | -   | -   | 2   | 2   | -    | -    | -    | 3    | 2    |
| CO5    | 2   | 2   | 3   | 1   | -   | -   | -   | 2   | 2   | -    | -    | -    | 3    | 2    |

### Syllabus

#### Unit 1

Structured to Object Oriented Approach by Examples - Object Oriented languages - Properties of Object Oriented system - UML and Object Oriented Software Development - Use case diagrams as a functional model - Identifying Objects and Representation by Object Diagram - state and behaviour - Identifying classes and CRC Cards - Simple Class using class diagram – Encapsulation - Data Hiding - Reading and Writing Objects - Class Level and Instance Level Attributes and Methods - Generalization using Class Diagram – Inheritance - Constructor and Over Riding – Visibility – Attribute – Parameter – Package - Local and Global.

#### Unit 2

Aggregation and Composition using Class Diagram – Polymorphism – Overloading - Abstract Classes and Interfaces - Exception Handling - Inner Classes - Wrapper classes – String - and String Builder classes – Number – Math – Random - Array methods - File Streams.

#### Unit 3

Generics - Collection framework - Comparator and Comparable - Vector and Arraylist - Iterator and Iterable - Introduction to Threads - Creating Threads - Thread States - Runnable Threads - Coordinating Threads - Interrupting Threads - Runnable Interface - Swings – Frame Layouts – Widgets - displaying image and graphics.

#### Text Book(s)

Weisfeld M., “The object-oriented thought process”, Third edition, Addison-Wesley Professional, 2013.

Wampler BE. :The Essence of Object-Oriented Programming with Java and UML”, Addison-Wesley Professional, 2002.



**Reference(s)**

Deitel PJ. “Java how to program”, Eleventh Edition, Pearson; 2018.

Nino J, Hosch FA. “Introduction to programming and object-oriented design using Java”, Wiley India Private Limited; 2010.

Naughton P. and Schildt H., “Java 2: the complete reference”, Eighth Edition, Tata McGraw- Hill; 2011.

Bahrami A. “Object Oriented Systems Development”, Second Edition, McGraw-Hill; 2008.

Booch G, Maksimchuk RA. “Object-oriented Analysis and Design with Applications”, Third Edition, Pearson Education; 2009.

**Evaluation Pattern**

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\*CA – Can be Quizzes, Assignment, Projects, and Reports.