

**ANNA UNIVERSITY, CHENNAI**  
**NON - AUTONOMOUS COLLEGES AFFILIATED ANNA UNIVERSITY**  
**M.E. APPLIED ELECTRONICS**  
**REGULATIONS – 2021**  
**CHOICE BASED CREDIT SYSTEM**


**1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):**

- To enable graduates to develop solutions to real world problems in the frontier areas of Applied Electronics.
- To enable the graduates to adapt to the latest trends in technology through self-learning and to pursue research to meet out the demands in industries and Academia.
- To enable the graduates to exhibit leadership skills and enhance their abilities through lifelong learning.
- To become entrepreneurs to develop indigenous solutions.

**2. PROGRAM OUTCOMES (POs)**

1. An ability to independently carry out research/investigation and development work to solve practical problems
2. An ability to write and present a substantial technical report/document  
Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
3. To critically evaluate the design and provide optimal solutions to problem areas in advanced signal processing, Consumer and automotive systems, embedded systems and VLSI design.
4. To enhance and develop electronic systems, protocols between circuits using modern engineering hardware and software tools.
5. To acquire knowledge of fundamentals of power electronics, power management, wireless, power supply circuits, RF circuits and FPGA circuits
- 6.

PROGRESS THROUGH KNOWLEDGE

  
**Principal**  
J.K.K. Munirajah College of Technology  
(Autonomous)  
T.N. Palayam, Gobi (Tk),  
Erode (Dt) - 638 506.

### MAPPING OF COURSE OUTCOMES AND PROGRAMME OUTCOMES

|                        |                              | <b>COURSE NAME</b>                            | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> |
|------------------------|------------------------------|---|------------|------------|------------|------------|------------|------------|
| <b>YEAR I</b>          | <b>SEMESTER I</b>            | Applied Mathematics for Electronics Engineers |            |            |            |            |            |            |
|                        |                              | Research Methodology and IPR                  |            |            |            |            |            |            |
|                        |                              | Advanced Digital Signal Processing            | -          | -          | 3          | 3          | 2          | -          |
|                        |                              | Advanced Digital System Design                | 2          | -          | 3          | 3          | 3          | 2          |
|                        |                              | Semiconductor Devices and Modeling            | 2          | -          | 2          | 1          | 1          | -          |
|                        |                              | Digital CMOS VLSI Design                      | 1          | -          | 3          | 2          | 2          | 2          |
|                        |                              | Electronics System Design Laboratory          | 2          | -          | 3          | 2          | 2          | 3          |
|                        | Signal Processing Laboratory | 2   | 2          | 2          | -          | 2          | 1          |            |
|                        | <b>SEMESTER II</b>           | Analog and Mixed Signal IC Design             | 3          | -          | 3          | 2          | 2          | 2          |
|                        |                              | Industrial Internet of Things                 | -          | -          | 2          | 1          | 2          | 1          |
|                        |                              | Power Conversion Circuits for Electronics     | 2          | -          | 2          | 2          | 2          | 2          |
| Embedded Systems       |                              | 2   | -          | 2          | 1          | 2          | 1          |            |
| VLSI Design Laboratory |                              | 2   | -          | -          | 2          | 2          | 2          |            |
| <b>YEAR II</b>         | <b>SEM III</b>               | Project Work I                                |            |            |            |            |            |            |
|                        |                              |   |            |            |            |            |            |            |
|                        |                              |   |            |            |            |            |            |            |
|                        | <b>SEMESTER IV</b>           | Project Work II                               |            |            |            |            |            |            |

ANNA UNIVERSITY  
PROGRESS THROUGH KNOWLEDGE

### PROFESSIONAL ELECTIVE COURSES [PEC]

| S. NO. | COURSE TITLE  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|--------|---|-----|-----|-----|-----|-----|-----|
| 1.     | Applications Specific Integrated Circuits                   | 1   | -   | 2   | 3   | 3   | 2   |
| 2.     | Computer Architecture and Parallel Processing               | 1   | -   | 1   | 2   | 1   | 3   |
| 3.     | Automotive Electronics                                      | 3   | -   | 2   | 3   | 1   | 2   |
| 4.     | Robotics  | 2   | -   | 1   | 3   | -   | 3   |
| 5.     | Soft Computing and Optimization Techniques                  | 3   | -   | 3   | 1   | 3   | 1   |
| 6.     | RF System Design  | 3   | -   | 3   | 1   | -   | 3   |
| 7.     | Electromagnetic Interference and Compatibility              | -   | -   | 1   | -   | 2   | 3   |
| 8.     | VLSI Design Techniques                                      | 1   | -   | 1   | 2   | 1   | 3   |
| 9.     | Nano Technologies   | 1   | -   | 1   | 3   | 1   | 3   |
| 10.    | VLSI Testing  | 1   | -   | 1   | 2   | 2   | 3   |
| 11.    | Edge Analytics and Internet of Things                       | 1   | -   | 1   | 2   | 3   | 3   |
| 12.    | Quantum Computing   | 1   | 2   | 3   | 2   | 2   | 2   |
| 13.    | VLSI for Wireless Communication                             | -   | -   | 2   | 2   | 2   | 2   |
| 14.    | Micro Electro Mechanical Systems                            | 2   | 1   | 2   | 1   | -   | 3   |
| 15.    | Hardware Secure Computing                                   | 1   | -   | 1   | 2   | 1   | 3   |
| 16.    | CAD for VLSI Design   | -   | -   | 2   | 2   | -   | 1   |
| 17.    | Sensors and Actuators                                       | 1   | -   | 1   | 2   | 1   | 3   |
| 18.    | Signal Integrity for High Speed Design                      | -   | -   | 3   | 1   | 2   | -   |
| 19.    | Consumer Electronics  | -   | -   | 2   | 1   | 2   | 2   |
| 20.    | Advanced Microprocessors and Microcontrollers Architectures | -   | 1   | 2   | 1   | -   | -   |
| 21.    | Biomedical Signal Processing                                | 1   | -   | 1   | 2   | 1   | 3   |
| 22.    | Modeling and Synthesis with HDL                             | 2   | -   | 2   | 2   | 3   | 2   |
| 23.    | Deep Learning   | 3   | -   | 2   | 3   | 2   | -   |
| 24.    | Advanced Digital Image Processing                           | 2   | -   | 2   | 3   | 2   | 1   |
| 25.    | PCB Design  | 2   | -   | -   | 3   | 2   | 1   |

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**M.E. APPLIED ELECTRONICS**  
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**CHOICE BASED CREDIT SYSTEM**  
**I TO IV SEMESTERS CURRICULA AND SYLLABI**  
**SEMESTER I**

| S. NO.            | COURSE CODE | COURSE TITLE                                  | CATE-GORY | PERIODS PER WEEK |          |          | TOTAL CONTACT PERIODS | CREDITS   |
|-------------------|-------------|---|-----------|------------------|----------|----------|-----------------------|-----------|
|                   |             |   |           | L                | T        | P        |                       |           |
| <b>THEORY</b>     |             |   |           |                  |          |          |                       |           |
| 1.                | MA4101      | Applied Mathematics for Electronics Engineers | FC        | 3                | 1        | 0        | 4                     | 4         |
| 2.                | RM4151      | Research Methodology and IPR                  | RMC       | 2                | 0        | 0        | 2                     | 2         |
| 3.                | AP4151      | Advanced Digital Signal Processing            | PCC       | 3                | 0        | 0        | 3                     | 3         |
| 4.                | AP4152      | Advanced Digital System Design                | PCC       | 3                | 0        | 2        | 5                     | 4         |
| 5.                | AP4153      | Semiconductor Devices and Modeling            | PCC       | 3                | 0        | 0        | 3                     | 3         |
| 6.                | VL4152      | Digital CMOS VLSI Design                      | PCC       | 3                | 0        | 0        | 3                     | 3         |
| 7.                |             | Audit Course – I*                             | AC        | 2                | 0        | 0        | 2                     | 0         |
| <b>PRACTICALS</b> |             |   |           |                  |          |          |                       |           |
| 8.                | AP4111      | Electronics System Design Laboratory          | PCC       | 0                | 0        | 3        | 3                     | 1.5       |
| 9.                | AP4112      | Signal Processing Laboratory                  | PCC       | 0                | 0        | 3        | 3                     | 1.5       |
| <b>TOTAL</b>      |             |   |           | <b>19</b>        | <b>1</b> | <b>8</b> | <b>28</b>             | <b>22</b> |

\*Audit course is optional

**SEMESTER II**

| S. NO.            | COURSE CODE | COURSE TITLE                              | CATE-GORY | PERIODS PER WEEK |          |          | TOTAL CONTACT PERIODS | CREDITS   |
|-------------------|-------------|---|-----------|------------------|----------|----------|-----------------------|-----------|
|                   |             |   |           | L                | T        | P        |                       |           |
| <b>THEORY</b>     |             |   |           |                  |          |          |                       |           |
| 1.                | AP4201      | Analog and Mixed Signal IC Design         | PCC       | 3                | 0        | 0        | 3                     | 3         |
| 2.                | AP4251      | Industrial Internet of Things             | PCC       | 3                | 0        | 0        | 3                     | 3         |
| 3.                | AP4202      | Power Conversion Circuits for Electronics | PCC       | 3                | 0        | 0        | 3                     | 3         |
| 4.                | AP4203      | Embedded Systems                          | PCC       | 3                | 0        | 2        | 5                     | 4         |
| 5.                |             | Professional Elective I                   | PEC       | 3                | 0        | 0        | 3                     | 3         |
| 6.                |             | Professional Elective II                  | PEC       | 3                | 0        | 0        | 3                     | 3         |
| 7.                |             | Audit Course – II*                        | AC        | 2                | 0        | 0        | 2                     | 0         |
| <b>PRACTICALS</b> |             |   |           |                  |          |          |                       |           |
| 8.                | AP4211      | VLSI Design Laboratory                    | PCC       | 0                | 0        | 4        | 4                     | 2         |
| 9.                | AP4212      | Mini Project with seminar                 | EEC       | 0                | 0        | 2        | 2                     | 1         |
| <b>TOTAL</b>      |             |   |           | <b>20</b>        | <b>0</b> | <b>8</b> | <b>28</b>             | <b>22</b> |

\*Audit course is optional

### SEMESTER III

| S. NO.            | COURSE CODE | COURSE TITLE              | CATEGORY | PERIODS PER WEEK |          |           | TOTAL CONTACT PERIODS | CREDITS   |
|-------------------|-------------|---------------------------|----------|------------------|----------|-----------|-----------------------|-----------|
|                   |             |                           |          | L                | T        | P         |                       |           |
| <b>THEORY</b>     |             |                           |          |                  |          |           |                       |           |
| 1.                |             | Professional Elective III | PEC      | 3                | 0        | 0         | 3                     | 3         |
| 2.                |             | Professional Elective IV  | PEC      | 3                | 0        | 0         | 3                     | 3         |
| 3.                |             | Professional Elective V   | PEC      | 3                | 0        | 2         | 5                     | 4         |
| 4.                |             | Open Elective             | OEC      | 3                | 0        | 0         | 3                     | 3         |
| <b>PRACTICALS</b> |             |                           |          |                  |          |           |                       |           |
| 5.                | AP4311      | Project Work I            | EEC      | 0                | 0        | 12        | 12                    | 6         |
| <b>TOTAL</b>      |             |                           |          | <b>12</b>        | <b>0</b> | <b>14</b> | <b>26</b>             | <b>19</b> |

### SEMESTER IV

| S. NO.            | COURSE CODE | COURSE TITLE    | CATEGORY | PERIODS PER WEEK |          |           | TOTAL CONTACT PERIODS | CREDITS   |
|-------------------|-------------|-----------------|----------|------------------|----------|-----------|-----------------------|-----------|
|                   |             |                 |          | L                | T        | P         |                       |           |
| <b>PRACTICALS</b> |             |                 |          |                  |          |           |                       |           |
| 1.                | AP4411      | Project Work II | EEC      | 0                | 0        | 24        | 24                    | 12        |
| <b>TOTAL</b>      |             |                 |          | <b>0</b>         | <b>0</b> | <b>24</b> | <b>24</b>             | <b>12</b> |

**TOTAL NO. OF CREDITS:75**

### PROFESSIONAL ELECTIVES SEMESTER II, ELECTIVE I

| S. NO. | COURSE CODE | COURSE TITLE                                  | CATEGORY | PERIODS PER WEEK |   |   | TOTAL CONTACT PERIODS | CREDITS |
|--------|-------------|---|----------|------------------|---|---|-----------------------|---------|
|        |             |   |          | L                | T | P |                       |         |
| 1.     | AP4001      | Applications Specific Integrated Circuits     | PEC      | 3                | 0 | 0 | 3                     | 3       |
| 2.     | AP4071      | Computer Architecture and Parallel Processing | PEC      | 3                | 0 | 0 | 3                     | 3       |
| 3.     | AP4091      | Automotive Electronics                        | PEC      | 3                | 0 | 0 | 3                     | 3       |
| 4.     | AP4094      | Robotics                                      | PEC      | 3                | 0 | 0 | 3                     | 3       |
| 5.     | VL4092      | Soft Computing and Optimization Techniques    | PEC      | 3                | 0 | 0 | 3                     | 3       |

### SEMESTER II, ELECTIVE II

| S. NO. | COURSE CODE | COURSE TITLE                                   | CATE-GORY | PERIODS PER WEEK |   |   | TOTAL CONTACT PERIODS | CREDITS |
|--------|-------------|--|-----------|------------------|---|---|-----------------------|---------|
|        |             |  |           | L                | T | P |                       |         |
| 1.     | CU4251      | RF System Design                               | PEC       | 3                | 0 | 0 | 3                     | 3       |
| 2.     | EL4071      | Electromagnetic Interference and Compatibility | PEC       | 3                | 0 | 0 | 3                     | 3       |
| 3.     | AP4003      | VLSI Design Techniques                         | PEC       | 3                | 0 | 0 | 3                     | 3       |
| 4.     | AP4004      | Nano Technologies                              | PEC       | 3                | 0 | 0 | 3                     | 3       |
| 5.     | VL4252      | VLSI Testing                                   | PEC       | 3                | 0 | 0 | 3                     | 3       |
| 6.     | AP4092      | Edge Analytics and Internet of Things          | PEC       | 3                | 0 | 0 | 3                     | 3       |

### SEMESTER III, ELECTIVE III

| S. NO. | COURSE CODE | COURSE TITLE                     | CATE-GORY | PERIODS PER WEEK |   |   | TOTAL CONTACT PERIODS | CREDITS |
|--------|-------------|----------------------------------|-----------|------------------|---|---|-----------------------|---------|
|        |             |                                  |           | L                | T | P |                       |         |
| 1.     | AP4093      | Quantum Computing                | PEC       | 3                | 0 | 0 | 3                     | 3       |
| 2.     | CU4076      | VLSI for Wireless Communication  | PEC       | 3                | 0 | 0 | 3                     | 3       |
| 3.     | AP4005      | Micro Electro Mechanical Systems | PEC       | 3                | 0 | 0 | 3                     | 3       |
| 4.     | AP4006      | Hardware Secure Computing        | PEC       | 3                | 0 | 0 | 3                     | 3       |
| 5.     | VL4072      | CAD for VLSI Design              | PEC       | 3                | 0 | 0 | 3                     | 3       |

### SEMESTER III, ELECTIVE IV

| S. NO. | COURSE CODE | COURSE TITLE  | CATE-GORY | PERIODS PER WEEK |   |   | TOTAL CONTACT PERIODS | CREDITS |
|--------|-------------|---|-----------|------------------|---|---|-----------------------|---------|
|        |             |   |           | L                | T | P |                       |         |
| 1.     | AP4073      | Sensors and Actuators                                       | PEC       | 3                | 0 | 0 | 3                     | 3       |
| 2.     | AP4095      | Signal Integrity for High Speed Design                      | PEC       | 3                | 0 | 0 | 3                     | 3       |
| 3.     | AP4007      | Consumer Electronics  | PEC       | 3                | 0 | 0 | 3                     | 3       |
| 4.     | AP4008      | Advanced Microprocessors and Microcontrollers Architectures | PEC       | 3                | 0 | 0 | 3                     | 3       |
| 5.     | AP4009      | Biomedical Signal Processing                                | PEC       | 3                | 0 | 0 | 3                     | 3       |

**SEMESTER III, ELECTIVE V**

| S. NO. | COURSE CODE | COURSE TITLE                      | CATE-GORY | PERIODS PER WEEK |   |   | TOTAL CONTACT PERIODS | CREDITS |
|--------|-------------|-----------------------------------|-----------|------------------|---|---|-----------------------|---------|
|        |             |                                   |           | L                | T | P |                       |         |
| 1.     | AP4010      | Modeling and Synthesis with HDL   | PEC       | 3                | 0 | 2 | 5                     | 4       |
| 2.     | IF4071      | Deep Learning                     | PEC       | 3                | 0 | 2 | 5                     | 4       |
| 3.     | AP4011      | Advanced Digital Image Processing | PEC       | 3                | 0 | 2 | 5                     | 4       |
| 4.     | AP4072      | PCB Design                        | PEC       | 3                | 0 | 2 | 5                     | 4       |

**AUDIT COURSES (AC)**

Registration for any of these courses is optional to students

| SL. NO | COURSE CODE | COURSE TITLE                       | PERIODS PER WEEK |   |   | CREDITS |
|--------|-------------|------------------------------------|------------------|---|---|---------|
|        |             |                                    | L                | T | P |         |
| 1.     | AX4091      | English for Research Paper Writing | 2                | 0 | 0 | 0       |
| 2.     | AX4092      | Disaster Management                | 2                | 0 | 0 | 0       |
| 3.     | AX4093      | Constitution of India              | 2                | 0 | 0 | 0       |
| 4.     | AX4094      | நற்றமிழ் இலக்கியம்                 | 2                | 0 | 0 | 0       |

**LIST OF OPEN ELECTIVES FOR PG PROGRAMMES**

| SL. NO. | COURSE CODE | COURSE TITLE   | PERIODS PER WEEK |   |   | CREDITS |
|---------|-------------|--|------------------|---|---|---------|
|         |             |  | L                | T | P |         |
| 1.      | OCE431      | Integrated Water Resources Management                  | 3                | 0 | 0 | 3       |
| 2.      | OCE432      | Water, Sanitation and Health                           | 3                | 0 | 0 | 3       |
| 3.      | OCE433      | Principles of Sustainable Development                  | 3                | 0 | 0 | 3       |
| 4.      | OCE434      | Environmental Impact Assessment                        | 3                | 0 | 0 | 3       |
| 5.      | OIC431      | Blockchain Technologies                                | 3                | 0 | 0 | 3       |
| 6.      | OIC432      | Deep Learning  | 3                | 0 | 0 | 3       |
| 7.      | OME431      | Vibration and Noise Control Strategies                 | 3                | 0 | 0 | 3       |
| 8.      | OME432      | Energy Conservation and Management in Domestic Sectors | 3                | 0 | 0 | 3       |
| 9.      | OME433      | Additive Manufacturing                                 | 3                | 0 | 0 | 3       |
| 10.     | OME434      | Electric Vehicle Technology                            | 3                | 0 | 0 | 3       |
| 11.     | OME435      | New Product Development                                | 3                | 0 | 0 | 3       |
| 12.     | OBA431      | Sustainable Management                                 | 3                | 0 | 0 | 3       |

|     |        |                                     |   |   |   |   |
|-----|--------|-------------------------------------|---|---|---|---|
| 13. | OBA432 | Micro and Small Business Management | 3 | 0 | 0 | 3 |
| 14. | OBA433 | Intellectual Property Rights        | 3 | 0 | 0 | 3 |
| 15. | OBA434 | Ethical Management                  | 3 | 0 | 0 | 3 |
| 16. | ET4251 | IoT for Smart Systems               | 3 | 0 | 0 | 3 |
| 17. | ET4072 | Machine Learning and Deep Learning  | 3 | 0 | 0 | 3 |
| 18. | PX4012 | Renewable Energy Technology         | 3 | 0 | 0 | 3 |
| 19. | PS4093 | Smart Grid                          | 3 | 0 | 0 | 3 |
| 20. | CP4391 | Security Practices                  | 3 | 0 | 0 | 3 |
| 21. | MP4251 | Cloud Computing Technologies        | 3 | 0 | 0 | 3 |
| 22. | IF4072 | Design Thinking                     | 3 | 0 | 0 | 3 |
| 23. | MU4153 | Principles of Multimedia            | 3 | 0 | 0 | 3 |
| 24. | CX4016 | Environmental Sustainability        | 3 | 0 | 0 | 3 |
| 25. | TX4092 | Textile Reinforced Composites       | 3 | 0 | 0 | 3 |
| 26. | NT4002 | Nanocomposite Materials             | 3 | 0 | 0 | 3 |
| 27. | BY4016 | IPR, Biosafety and Entrepreneurship | 3 | 0 | 0 | 3 |

#### FOUNDATION COURSES (FC)

| S. NO | COURSE CODE | COURSE TITLE                                  | PERIODS PER WEEK |          |           | CREDITS | SEMESTER |
|-------|-------------|---|------------------|----------|-----------|---------|----------|
|       |             |   | Lecture          | Tutorial | Practical |         |          |
| 1.    | MA4101      | Applied Mathematics for Electronics Engineers | 3                | 1        | 0         | 4       | I        |

#### PROFESSIONAL CORE COURSES (PCC)

| S. NO | COURSE CODE | COURSE TITLE                              | PERIODS PER WEEK |          |           | CREDITS | SEMESTER |
|-------|-------------|---|------------------|----------|-----------|---------|----------|
|       |             |   | Lecture          | Tutorial | Practical |         |          |
| 1.    | AP4151      | Advanced Digital Signal Processing        | 3                | 0        | 0         | 3       | I        |
| 2.    | AP4152      | Advanced Digital System Design            | 3                | 0        | 2         | 4       | I        |
| 3.    | AP4153      | Semiconductor Devices and                 | 3                | 0        | 0         | 3       | I        |
| 4.    | VL4152      | Digital CMOS VLSI Design                  | 3                | 0        | 0         | 3       | I        |
| 5.    | AP4111      | Electronics System Design Laboratory      | 0                | 0        | 3         | 1 . 5   | I        |
| 6.    | AP4112      | Signal Processing Laboratory              | 0                | 0        | 3         | 1 . 5   | I        |
| 7.    | AP4201      | Analog and Mixed Signal IC Design         | 3                | 0        | 0         | 3       | II       |
| 8.    | AP4251      | Industrial Internet of Things             | 3                | 0        | 0         | 3       | II       |
| 9.    | AP4202      | Power Conversion Circuits for Electronics | 3                | 0        | 0         | 3       | II       |
| 10.   | AP4203      | Embedded Systems                          | 3                | 0        | 2         | 4       | II       |

|     |        |                        |   |   |   |   |    |
|-----|--------|------------------------|---|---|---|---|----|
| 11. | AP4211 | VLSI Design Laboratory | 0 | 0 | 4 | 2 | II |
|-----|--------|------------------------|---|---|---|---|----|

### RESEARCH METHODOLOGY AND IPR COURSES (RMC)

| S. NO | COURSE CODE | COURSE TITLE                 | PERIODS PER WEEK |          |           | CREDITS | SEMESTER |
|-------|-------------|------------------------------|------------------|----------|-----------|---------|----------|
|       |             |                              | Lecture          | Tutorial | Practical |         |          |
| 1.    | RM4151      | Research Methodology and IPR | 2                | 0        | 0         | 2       | 1        |

### EMPLOYABILITY ENHANCEMENT COURSES (EEC)

| S. NO | COURSE CODE | COURSE TITLE              | PERIODS PER WEEK |          |           | CREDITS | SEMESTER |
|-------|-------------|---------------------------|------------------|----------|-----------|---------|----------|
|       |             |                           | Lecture          | Tutorial | Practical |         |          |
| 1.    | AP4212      | Mini Project with seminar | 0                | 0        | 2         | 1       | II       |
| 2.    | AP4311      | Project Work I            | 0                | 0        | 12        | 6       | III      |
| 3.    | AP4411      | Project Work II           | 0                | 0        | 24        | 12      | IV       |

### SUMMARY

| Sl. No. | NAME OF THE PROGRAMME: M.E. APPLIED ELECTRONICS |                      |           |           |           |               |
|---------|---|----------------------|-----------|-----------|-----------|---------------|
|         | SUBJECT AREA                                    | CREDITS PER SEMESTER |           |           |           | CREDITS TOTAL |
|         |   | I                    | II        | III       | IV        |               |
| 1.      | FC  | 04                   | 00        | 00        | 00        | 04            |
| 2.      | PCC   | 16                   | 15        | 00        | 00        | 31            |
| 3.      | PEC   | 00                   | 06        | 10        | 00        | 16            |
| 4.      | RMC   | 02                   | 00        | 00        | 00        | 02            |
| 5.      | OEC   | 00                   | 00        | 03        | 00        | 03            |
| 6.      | EEC   | 00                   | 01        | 06        | 12        | 19            |
| 7.      | Non Credit/Audit Course                         | ✓                    | ✓         | 00        | 00        |               |
| 8.      | <b>TOTAL CREDIT</b>                             | <b>22</b>            | <b>22</b> | <b>19</b> | <b>12</b> | <b>75</b>     |

**COURSE OBJECTIVES:**

- To introduce the fundamentals of fuzzy logic.
- To understand the basics of random variables with emphasis on the standard discrete and continuous distributions.
- To understand the basic probability concepts with respect to two dimensional random variables.
- To make students understand the notion of a Markov chain, and how simple ideas of conditional probability and matrices can be used to give a thorough and effective account of discrete – time Markov chains.
- To provide the required fundamental concepts in queueing models and apply these techniques in networks, image processing.

**UNIT I FUZZY LOGIC****12**

Classical logic – Multivalued logics – Fuzzy propositions – Fuzzy qualifiers.

**UNIT II PROBABILITY AND RANDOM VARIABLES****12**

Probability – Axioms of probability – Conditional probability – Bayes theorem – Random variables – Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a random variable.

**UNIT III TWO DIMENSIONAL RANDOM VARIABLES****12**

Joint distributions – Marginal and conditional distributions – Functions of two dimensional random variables – Regression curve – Correlation.

**UNIT IV RANDOM PROCESSES****12**

Classification – Stationary random process – Markov process – Markov chain – Poisson process – Gaussian process - Auto correlation – Cross correlation.

**UNIT V QUEUEING MODELS****12**

Poisson process – Markovian queues – Single and multi server models – Little's formula – Machine Interference model – Steady state analysis – Self service queue.

**TOTAL : 60 PERIODS****COURSE OUTCOMES:**

At the end of the course, students will be able to

- apply the concepts of fuzzy sets, fuzzy logic, fuzzy prepositions and fuzzy quantifiers and in relate.
- analyze the performance in terms of probabilities and distributions achieved by the determined solutions.
- use some of the commonly encountered two dimensional random variables and extend to multivariate analysis.
- classify various random processes and solve problems involving stochastic processes.
- use queueing models to solve practical problems.

## REFERENCES:

1. Ganesh M., "Introduction to Fuzzy Sets and Systems, Theory and Applications", Academic Press, New York, 1997.
2. George J. Klir and Yuan B., "Fuzzy sets and Fuzzy logic" Prentice Hall, New Delhi, 2006.
3. Devore J.L, "Probability and Statistics for Engineering and Sciences", Cengage learning, 9<sup>th</sup> Edition, Boston, 2017.
4. Johnson R.A. and Gupta, C.B., " Miller and Freunds Probability and Statistics for Engineers", Pearson India Education, Asia, 9<sup>th</sup> Edition, New Delhi, 2017.
5. Oliver C. Ibe," Fundamentals of applied probability and Random process", Academic press, Boston, 2014.
6. Gross D. and Harris C.M., "Fundamentals of Queuing theory", Willey student, 3<sup>rd</sup> Edition, New Jersey, 2004.

RM4151

RESEARCH METHODOLOGY AND IPR

L T P C  
2 0 0 2

### UNIT I RESEARCH DESIGN 6

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

### UNIT II DATA COLLECTION AND SOURCES 6

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

### UNIT III DATA ANALYSIS AND REPORTING 6

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

### UNIT IV INTELLECTUAL PROPERTY RIGHTS 6

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

### UNIT V PATENTS 6

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filing, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

**TOTAL:30 PERIODS**

## REFERENCES

1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.



**CO5:** Design discrete time system for the given application using Multi rate signal processing

**REFERENCES:**

1. J.G.Proakis & D. G.Manolakis Digital Signal Processing: Principles, Algorithms & Applications -, 4th Ed., Pearson Education, 2013.
2. Alan V Oppenheim & Ronald W Schaffer Discrete Time signal processing, Pearson Education, 2014.
3. Keshab K. Parhi, 'VLSI Digital Signal Processing Systems Design and Implementation', John Wiley& Sons, 2007.
4. Steven. M .Kay, Modern Spectral Estimation: Theory & Application –PHI, 2009.
5. P.P.Vaidyanathan, Multi Rate Systems and Filter Banks , Pearson Education, 1993.
6. Emmanuel C. Ifeachor, Barrie W. Jervis, "Digital Signal Processing–A practical approach", Second Edition, Harlow, Prentice Hall, 2011.

**CO-PO Mapping**

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1          | -   | -   | 3   | 2   | -   | -   |
| 2          | -   | -   | 3   | 3   | -   | -   |
| 3          | -   | -   | 2   | 3   | -   | -   |
| 4          | -   | -   | -   | 2   | 2   | -   |
| 5          | -   | -   | 2   | -   | 2   | -   |
| <b>Avg</b> | -   | -   | 3   | 3   | 2   | -   |

**AP4152**

**ADVANCED DIGITAL SYSTEM DESIGN**

**L T P C  
3 0 2 4**

**COURSE OBJECTIVES:**

- To design asynchronous sequential circuits.
- To learn about hazards in asynchronous sequential circuits.
- To study the fault testing procedure for digital circuits.
- To understand the architecture of programmable devices.
- To design and implement digital circuits using programming tools.

**UNIT I SEQUENTIAL CIRCUIT DESIGN**

**9**

Analysis of Clocked Synchronous Sequential Circuits and Modelling- State Diagram, State Table, State Table Assignment and Reduction-Design of Synchronous Sequential Circuits Design of Iterative Circuits-ASM Chart and Realization using ASM.

**UNIT II ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN**

**9**

Analysis of Asynchronous Sequential Circuit – Flow Table Reduction-Races-State Assignment-Transition Table and Problems in Transition Table- Design of Asynchronous Sequential Circuit - Static, Dynamic and Essential hazards – Mixed Operating Mode Asynchronous Circuits – Designing Vending Machine Controller.

**UNIT III FAULT DIAGNOSIS AND TESTABILITY ALGORITHMS 9**

Fault Table Method-Path Sensitization Method – Boolean Difference Method - D Algorithm — Tolerance Techniques – The Compact Algorithm – Fault in PLA – Test Generation - DFT Schemes – Built in Self Test.

**UNIT IV SYNCHRONOUS DESIGN USING PROGRAMMABLE DEVICES 9**

Programming Logic Device Families – Designing a Synchronous Sequential Circuit using PLA/PAL – Designing ROM with PLA – Realization of Finite State Machine using PLD – FPGA – Xilinx FPGA - Xilinx 4000.

**UNIT V SYSTEM DESIGN USING VERILOG 9**

Hardware Modelling with Verilog HDL – Logic System, Data Types And Operators For Modelling In Verilog HDL - Behavioural Descriptions In Verilog HDL – HDL Based Synthesis – Synthesis Of Finite State Machines– Structural Modelling – Compilation And Simulation Of Verilog Code – Test Bench - Realization Of Combinational And Sequential Circuits Using Verilog – Registers – Counters – Sequential Machine – Serial Adder – Multiplier- Divider – Design Of Simple Microprocessor, Introduction To System Verilog.

**45 PERIODS**

**SUGGESTED ACTIVITIES:**

- 1: Design asynchronous sequential circuits.
- 2: Design synchronous sequential circuits using PLA/PAL.
- 3: Simulation of digital circuits in FPGA.
- 4: Design digital systems with System Verilog.

**PRACTICAL EXERCISES:**

**30 PERIODS**

1. Design of Registers by Verilog HDL.
2. Design of Counters by Verilog HDL.
3. Design of Sequential Machines by Verilog HDL.
4. Design of Serial Adders , Multiplier and Divider by Verilog HDL.
5. Design of a simple Microprocessor by Verilog HDL.

**COURSE OUTCOMES:**

At the end of this course, the students will be able to:

- CO1:** Analyse and design synchronous sequential circuits.
- CO2:** Analyse hazards and design asynchronous sequential circuits.
- CO3:** Knowledge on the testing procedure for combinational circuit and PLA.
- CO4:** Able to design PLD and ROM.
- CO5:** Design and use programming tools for implementing digital circuits of industry standards.

**TOTAL:75 PERIODS**

**REFERENCES**

1. Charles H.Roth jr., “Fundamentals of Logic Design” Thomson Learning,2013.
2. M.D.Ciletti , Modeling, Synthesis and Rapid Prototyping with the Verilog HDL, Prentice Hall, 1999
3. M.G.Arnold, Verilog Digital – Computer Design, Prentice Hall (PTR), 1999.
4. Nripendra N Biswas “Logic Design Theory” Prentice Hall of India,2001.
5. Paragk.Lala “Fault Tolerant and Fault Testable Hardware Design” B S Publications,2002
6. Paragk.Lala “Digital System Design Using PLD” B S Publications,2003.

7. Palnitkar , Verilog HDL – A Guide to Digital Design and Synthesis, Pearson , 2003.

### CO-PO Mapping

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1          | 2   | -   | 2   | -   | -   | -   |
| 2          | 2   | -   | -   | 3   | -   | -   |
| 3          | -   | -   | -   | -   | 2   | 1   |
| 4          | -   | -   | 3   | -   | -   | 2   |
| 5          | -   | -   | -   | 2   | 3   | -   |
| <b>Avg</b> | 2   | -   | 3   | 3   | 3   | 2   |

AP4153

**SEMICONDUCTOR DEVICES AND MODELING**

**L T P C**

**3 0 0 3**

#### COURSE OBJECTIVES:

- To acquire the fundamental knowledge and to expose to the field of semiconductor theory and devices and their applications.
- To gain adequate understanding of semiconductor device modelling aspects, designing devices for electronic applications
- To acquire the fundamental knowledge of different semiconductor device modelling aspects.

#### UNIT I MOS CAPACITORS

**9**

Surface Potential: Accumulation, Depletion, and Inversion, Electrostatic Potential and Charge Distribution in Silicon, Capacitances in an MOS Structure, Polysilicon-Gate Work Function and Depletion Effects, MOS under Nonequilibrium and Gated Diodes, Charge in Silicon Dioxide and at the Silicon–Oxide Interface, Effect of Interface Traps and Oxide Charge on Device Characteristics, High-Field Effects, Impact Ionization and Avalanche Breakdown, Band-to-Band Tunneling, Tunneling into and through Silicon Dioxide, Injection of Hot Carriers from Silicon into Silicon Dioxide, High-Field Effects in Gated Diodes, Dielectric Breakdown.

#### UNIT II MOSFET DEVICES

**9**

Long-Channel MOSFETs, Drain-Current Model, MOSFET I–V Characteristics, Subthreshold Characteristics, Substrate Bias and Temperature Dependence of Threshold Voltage, MOSFET Channel Mobility, MOSFET Capacitances and Inversion-Layer Capacitance Effect, Short-Channel MOSFETs, Short-Channel Effect, Velocity Saturation and High-Field Transport Channel Length Modulation, Source–Drain Series Resistance, MOSFET Degradation and Breakdown at High Fields

#### UNIT III CMOS DEVICE DESIGN

**9**

CMOS Scaling, Constant-Field Scaling, Generalized Scaling, Nonscaling Effects, Threshold Voltage, Threshold-Voltage Requirement, Channel Profile Design, Nonuniform Doping, Quantum Effect on Threshold Voltage, Discrete Dopant Effects on Threshold Voltage, MOSFET Channel Length, Various Definitions of Channel Length, Extraction of the Effective Channel Length,

Physical Meaning of Effective Channel Length, Extraction of Channel Length by C–V Measurements.

**UNIT IV BIPOLAR DEVICES**

**9**

n–p–n Transistors, Basic Operation of a Bipolar Transistor, Modifying the Simple Diode Theory for Describing Bipolar Transistors, Ideal Current–Voltage Characteristics, Collector Current, Base Current, Current Gains, Ideal IC–VCE Characteristics, Characteristics of a Typical n–p–n Transistor, Effect of Emitter and Base Series Resistances, Effect of Base–Collector Voltage on Collector Current, Collector Current Falloff at High Currents, Nonideal Base Current at Low Currents, Bipolar Device Models for Circuit and Time-Dependent Analyses Basic dc Model, Basic ac Model, Small-Signal Equivalent-Circuit Model, Emitter Diffusion Capacitance, Charge-Control Analysis, Breakdown Voltages, Common-Base Current Gain in the Presence of Base–Collector Junction Avalanche, Saturation Currents in a Transistor.

**UNIT V MATHEMATICAL TECHNIQUES FOR DEVICE SIMULATIONS**

**9**

Poisson equation, continuity equation, drift-diffusion equation, Schrodinger equation, hydrodynamic equations, trap rate, finite difference solutions to these equations in 1D and 2D space, grid generation.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

**CO1:** Explore the properties of MOS capacitors.

**CO2:** Analyze the various characteristics of MOSFET devices.

**CO3:** Describe the various CMOS design parameters and their impact on performance of the device.

**CO4:** Discuss the device level characteristics of BJT transistors.

**CO5:** Identify the suitable mathematical technique for simulation.

**REFERENCES:**

1. Yuan Taur and Tak H.Ning, "Fundamentals of Modern VLSI Devices", Cambridge University Press, 2016.
2. A.B. Bhattacharyya "Compact MOSFET Models for VLSI Design", John Wiley & Sons Ltd, 2009.
3. Ansgar Jungel, "Transport Equations for Semiconductors", Springer, 2009
4. Trond Ytterdal, Yuhua Cheng and Tor A. Fjeldly Wayne Wolf, "Device Modeling for Analog and RF CMOS Circuit Design", John Wiley & Sons Ltd, 2004
5. Selberherr, S., "Analysis and Simulation of Semiconductor Devices", Springer-Verlag., 1984
6. Behzad Razavi, "Fundamentals of Microelectronics" Wiley Student Edition, 2<sup>nd</sup> Edition, 2014
7. J P Collinge, C A Collinge, "Physics of Semiconductor devices" Springer, 2002.
8. S.M.Sze, Kwok.K. NG, "Physics of Semiconductor devices", Springer, 2006.

**CO-PO Mapping**

| CO       | POs |     |     |     |     |     |
|----------|-----|-----|-----|-----|-----|-----|
|          | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| <b>1</b> | 2   | 1   | -   | -   | -   | -   |
| <b>2</b> | 1   | -   | 2   | -   | -   | -   |

|            |   |   |   |   |   |   |
|------------|---|---|---|---|---|---|
| <b>3</b>   | 2 | - | 1 | - | - | - |
| <b>4</b>   | - | - | 2 | 1 | - | - |
| <b>5</b>   | 2 | - | - | - | 1 | - |
| <b>Avg</b> | 2 | - | 2 | 1 | 1 | - |

VL4152

**DIGITAL CMOS VLSI DESIGN**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To introduce the transistor level design of all digital building blocks common to all cmos microprocessors, network processors, digital backend of all wireless systems etc.
- To introduce the principles and design methodology in terms of the dominant circuit choices, constraints and performance measures
- To learn all important issues related to size, speed and power consumption

**UNIT I MOS TRANSISTOR PRINCIPLES AND CMOS INVERTER 12**

MOSFET characteristic under static and dynamic conditions, MOSFET secondary effects, elmore constant , CMOS inverter-static characteristic, dynamic characteristic, power, energy, and energy delay parameters, stick diagram and layout diagrams.

**UNIT II COMBINATIONAL LOGIC CIRCUITS 9**

Static CMOS design, different styles of logic circuits, logical effort of complex gates, static and dynamic properties of complex gates, interconnect delay, dynamic logic gates.

**UNIT III SEQUENTIAL LOGIC CIRCUITS 9**

Static latches and registers, dynamic latches and registers, timing issues, pipelines, clocking strategies, nonbistable sequential circuits.

**UNIT IV ARITHMETIC BUILDING BLOCKS 9**

Data path circuits, architectures for adders, accumulators, multipliers, barrel shifters, speed, power and area tradeoffs.

**UNIT V MEMORY ARCHITECTURES 6**

Memory architectures and Memory control circuits: Read-Only Memories, ROM cells, Read-Write Memories (RAM), dynamic memory design, 6 Transistor SRAM cell, sense amplifiers.

**COURSE OUTCOMES:**

At the end of this course, the students will be able to:

- CO1:** Use mathematical methods and circuit analysis models in analysis of CMOS digital circuits
- CO2:** Create models of moderately sized static CMOS combinational circuits that realize specified digital functions and to optimize combinational circuit delay using RC delay models and logical effort
- CO3:** Design sequential logic at the transistor level and compare the tradeoffs of sequencing elements including flip-flops, transparent latches
- CO4:** Understand design methodology of arithmetic building blocks

**CO5:** Design functional units including ROM and SRAM

**TOTAL:45 PERIODS**

**REFERENCES:**

1. N.Weste, K. Eshraghian, “ Principles Of Cmos VLSI Design”, Addison Wesley, 2<sup>nd</sup> Edition, 1993
2. M J Smith, “Application Specific Integrated Circuits”, Addison Wesley, 1997
3. Sung-Mo Kang & Yusuf Leblebici, “CMOS Digital Integrated Circuits Analysis And Design”, McGraw-Hill, 1998
4. Jan Rabaey, Anantha Chandrakasan, B Nikolic, “ Digital Integrated Circuits: A Design Perspective”, Prentice Hall Of India, 2<sup>nd</sup> Edition, Feb 2003

**CO-PO Mapping**

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1          | 1   | -   | 2   | -   | -   | -   |
| 2          | -   | -   | 3   | 2   | -   | -   |
| 3          | -   | -   | 3   | 3   | -   | -   |
| 4          | -   | -   | -   | 1   | 2   | 2   |
| 5          | -   | -   | -   | 2   | -   | 2   |
| <b>Avg</b> | 1   | -   | 3   | 2   | 2   | 2   |

**AP4111**

**ELECTRONICS SYSTEM DESIGN LABORATORY**

**L T P C**  
**0 0 3 1.5**

**COURSE OBJECTIVES:**

- Design of instrumentation amplifier and voltage regulator
- Design of PCB layout
- Write a Verilog HDL coding of various combinational circuits
- Verify the design functionality for various memory modules
- Design of PLL circuits

**LIST OF EXPERIMENTS:**

1. Design of a 4-20 mA transmitter for a bridge type transducer.

Design the Instrumentation amplifier with the bridge type transducer (Thermistor or any resistance variation transducers) and convert the amplified voltage from the instrumentation amplifier to 4 – 20 mA current using op-amp. Plot the variation of the temperature Vs output current.

2. Design of AC/DC voltage regulator using SCR

Design a phase controlled voltage regulator using full wave rectifier and SCR, vary the conduction angle and plot the output voltage.

### 3. PCB layout design using CAD

Drawing the schematic of simple electronic circuit and design of PCB layout using CAD

4. HDL based design entry and simulation of Parameterizable cores of Counters, Shift registers, State machines, 8-bit Parallel adders and 8 –Bit multipliers.

5. HDL based design entry and simulation of Parameterizable cores on the simple Distributed Arithmetic system. Test vector generation and timing analysis.

6. HDL based design entry and simulation of Parameterizable cores on memory design and 4 – bit ALU. Synthesis, P&R and post P&R simulation, Critical paths and static timing analysis results to be identified. FPGA real time programming and I/O interfacing.

7. Interfacing with Memory modules in FPGA Boards. Verifying design functionality by probing internal signals.

8. Realization of Discrete Fourier transform/Fast Fourier Transform algorithm in HDL and observing the spectrum in simulation.

9. Invoke PLL module and demonstrate the use of the PLL for clock generation in FPGAs. Verify design functionality implemented in FPGA by capturing the signal in Oscilloscope

**TOTAL :45 PERIODS**

#### **COURSE OUTCOMES:**

**CO1:** Design an instrumentation amplifier and voltage regulator

**CO2:** Design a PCB layout using CAD tool

**CO3:** Write a Verilog code for various combinational and sequential circuits

**CO4:** Develop a memory module with FPGA

**CO5:** Design an PLL circuit

#### **REFERENCES:**

1. Neil H.E. Weste, David Harris, Ayan Banerjee, "CMOS VLSI Design- A circuits and Systems Perspective", Third Edition, 2013, Pearson education.
2. M. Morris Mano, Michael D. Ciletti, "Digital Design with an introduction to Verilog HDL", PHI, 6th Edition, 2018
3. James E. Palmer, David E. Perlman, "Schuams Outlines-Introduction to Digital Systems", Tata McGraw Hill, 2nd Edition 2003
4. Sergio Franco, "Design with operational amplifiers and analog integrated circuits", 3rd Edition, Tata McGraw Hill, 2007
5. D.Roy Choudhry, Shail Jain, "Linear Integrated Circuits", New Age International Private Limited, 4th Edition, 2010

#### **CO-PO Mapping**

| CO | POs |     |     |     |     |     |
|----|-----|-----|-----|-----|-----|-----|
|    | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1  | 2   | -   | -   | -   | -   | -   |
| 2  | 2   | -   | -   | -   | 2   | -   |

|            |   |   |   |   |   |   |
|------------|---|---|---|---|---|---|
| <b>3</b>   | - | - | - | 2 | - | 3 |
| <b>4</b>   | - | - | - | 2 | - | 2 |
| <b>5</b>   | - | - | 3 | - | 2 | - |
| <b>Avg</b> | 2 | - | 3 | 2 | 2 | 3 |

AP4112

SIGNAL PROCESSING LABORATORY

L T P C  
0 0 3 1.5

**COURSE OBJECTIVES:**

- To provide the student with the basic understanding of audio signal analysis using filters
- To provide the students with the understanding of the working of statistical method based approaches
- To impart the students with the design of filters
- To demonstrate the working of algorithms for different applications
- To provide knowledge of analyzing the images and video

**LIST OF EXPERIMENTS:**

1. Design of Adaptive channel equalizer
2. Realization of sub band filter using linear convolution
3. Realization of STFT using FFT
4. Demonstration of Bayes technique
5. Demonstration of Min-max technique
6. Realization of FIR Wiener filter
7. Generation of Multivariate Gaussian generated data with desired mean vector and the required co-variance matrix.
8. Design and Realization of the adaptive filter using LMS algorithm (solved using steepest-descent algorithm)
9. Representation of the 2D image signal as the linear combinations of PCA (Eigen faces)
10. Image compression using Discrete cosine transformation (DCT).
11. Multiple-input Multiple output (MIMO)
12. Speech recognition using Support Vector Machine (SVM)
13. LMS filtering implementation using TMS320C6x processor
14. Face detection and tracking in video using OpenCV

**TOTAL :45 PERIODS**

**COURSE OUTCOMES:**

**CO1:** Obtain the ability to apply knowledge of linear algebra, random process and multirate signal processing in various signal processing applications.

**CO2:** Develop the student's ability on conducting engineering experiments, analyze experimental observations scientifically

**CO3:** Become familiar to fundamental principles of linear algebra

**CO4:** Familiarize the basic operations of filter banks through simulations

**CO5:** Apply the principles of random process in practical applications

## REFERENCES

1. Vinay K.Ingle,John G.Proakis, Digital signal processing using MATLAB, Cengage Learning, 3<sup>rd</sup> edition, 2011
2. Michael R King, Nipa Mody, Numerical and statistical methods for Bio Engineering – Applications using MATLAB , CAMBRIDGE University Press, 2010
3. V. Siahaan, R.H.Sianipar, Signal and Image processing with python GUI, Balige Publishing,2021

### CO-PO Mapping

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1          | 2   | 1   | -   | -   | -   | -   |
| 2          | 2   | 2   | -   | -   | -   | -   |
| 3          | 2   | -   | 2   | -   | -   | -   |
| 4          | -   | -   | 2   | -   | 2   | -   |
| 5          | -   | -   | 2   | -   | -   | 1   |
| <b>Avg</b> | 2   | 2   | 2   | -   | 2   | 1   |

AP4201

**ANALOG AND MIXED SIGNAL IC DESIGN**

**L T P C**  
**3 0 0 3**

### COURSE OBJECTIVES:

- To study the concepts of MOS large signal model and small signal model
- To provide in-depth understanding of the analog integrated circuit and building blocks
- To learn the Analog and Digital layout design for mixed signal circuits
- To Understand the methodologies for analysis and design of fundamental CMOS Analog and Mixed signal Circuits like Data Converters and filters.
- To study the integrated circuits like oscillators and PLLs.

### UNIT I

#### **INTRODUCTION AND BASIC MOS DEVICES**

**9**

Challenges in analog design-Mixed signal layout issues- MOS FET structures and characteristics- large signal model – small signal model- single stage Amplifier-Source follower-Common gate stage – Cascode Stage

### UNIT II

#### **SUBMICRON CIRCUIT DESIGN**

**9**

Submicron CMOS process flow, Capacitors and resistors, Current mirrors, The MOSFET Switch, Analog Circuit Design: Biasing, Op-Amp Design, Circuit Noise - OP Amp parameters

### UNIT III

#### **DATA CONVERTERS**

**9**

Characteristics of Sample and Hold- Digital to Analog Converters- architecture-Differential Non linearity-Integral Non linearity- Voltage Scaling-Cyclic DAC-Pipeline DAC-Analog to Digital Converters- architecture – Flash ADC-Pipeline ADC-Differential Non linearity-Integral Non linearity.

Overview of SNR of Data Converters- Clock Jitters- Improving Using Averaging – Decimating Filters for ADC- Band pass and High Pass Sinc Filters- Interpolating Filters for DAC

**UNIT IV ANALOG AND DIGITAL LAYOUT DESIGN FOR MIXED SIGNAL 9**

Layout introduction: Introduction, MOS transistor layers, stick diagram, symbolic diagram. Digital layout design: Introduction, guide line of transistor layout, PMOS and NMOS transistor layout, CMOS transistor layout. Introduction to analog layout techniques and Passive component layout - capacitor, resistor and inductor, Floor planning of analog and digital components, power supply and ground pin issues, matching, shielding, interconnection issues.

**UNIT V OSCILLATORS AND PLL 9**

LC oscillators, Voltage Controlled Oscillators. Simple PLL, Charge pumps PLLs, Non ideal effects in PLLs, Delay Locked Loops. Applications of PLL.frequency multiplication and synthesis. Introduction to RF IC Design, building blocks, applications.

**SUGGESTED ACTIVITIES:**

ICT/MOOCs Reference :  
<https://nptel.ac.in/courses/117/101/117101105/>

**COURSE OUTCOMES:**

At the end of this course the students will be able to:

**CO1:** Carry out research and development in the area of analog and mixed signal IC design.

**CO2:** Well versed with the MOS fundamentals, small signal models and analysis of MOSFET based circuits.

**CO3** Analyse and model data converters architecture

**CO4:** Understand and Design different mixed signal circuits for various applications as per the user specifications.

**CO5:** Analyze and design mixed signal circuits such as Comparator, ADCs, DACs, PLL.

**TOTAL : 45 PERIODS**

**REFERENCES**

1. P. Allen and D. Holberg, "CMOS Analog Circuit Design", Oxford University Press, Second Edition, 2012.
2. B. Razavi, "Design of Analog CMOS Integrated Circuits", McGraw Hill, 2003.
3. R.Jacob Baker,H.W.Li, and D.E. Boyce CMOS Circuit Design ,Layout and Simulation, Prentice-Hall of India,1998.
4. Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, Robert G. Meyer, "Analysis and Design of Analog Integrated Circuits", Wiley Publishers, Fifth Edition, 2009.

### CO-PO Mapping

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1          | 3   | -   | -   | -   | -   | -   |
| 2          | -   | -   | 3   | 1   | -   | -   |
| 3          | -   | -   | 2   | 2   | -   | -   |
| 4          | -   | -   | -   | 2   | 2   | -   |
| 5          | -   | -   | -   | 2   | -   | 2   |
| <b>Avg</b> | 3   | -   | 3   | 2   | 2   | 2   |

AP4251

**INDUSTRIAL INTERNET OF THINGS**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand the fundamentals of Internet of Things
- To learn about the basics of IOT protocols
- To build a small low cost embedded system using IoT
- To apply the concept of IOT in the real world scenario

**UNIT I INTRODUCTION AND ARCHITECTURE OF IoT 9**

Introduction – Definition and characteristics of IoT – Physical and Logical Design of IoT - Communication models and APIs – Challenges in IoT - Evolution of IoT- Components of IoT - A Simplified IoT Architecture – Core IoT Functional Stack.

**UNIT II INDUSTRIAL IoT 9**

IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture: IIoT-Business Models, Industrial IoT- Layers: IIoT Sensing, IIoT Processing, IIoT Communication, IIoT Networking

**UNIT III IIOT ANALYTICS 9**

Big Data Analytics and Software Defined Networks, Machine Learning and Data Science, Julia Programming, Data Management with Hadoop

**UNIT IV IOT SECURITY 9**

Industrial IoT: Security and Fog Computing - Cloud Computing in IIoT, Fog Computing in IIoT, Security in IIoT

**UNIT V CASE STUDY 9**

Industrial IOT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies: Milk Processing and Packaging Industries, Manufacturing Industries

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, student will be able to

**CO1:** Understand the basic concepts and Architectures of Internet of Things.

**CO2:** Understand various IoT Layers and their relative importance.

**CO3:** Realize the importance of Data Analytics in IoT.

**CO4:** Study various IoT platforms and Security

**CO5:** Understand the concepts of Design Thinking.

## REFERENCE BOOKS

1. Industry 4.0: The Industrial Internet of Things”, by Alasdair Gilchrist (Apress), 2017
2. “Industrial Internet of Things: Cybermanufacturing Systems”by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer), 2017
3. Hands-On Industrial Internet of Things: Create a powerful Industrial IoT by Giacomo Veneri, Antonio Capasso, Packt, 2018.

## CO-PO Mapping

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1          | -   | -   | 2   | 1   | -   | -   |
| 2          | -   | -   | 2   | 1   | -   | -   |
| 3          | -   | -   | 3   | 2   | -   | -   |
| 4          | -   | -   | -   | -   | 2   | -   |
| 5          | -   | -   | -   | -   | 1   | 1   |
| <b>Avg</b> | -   | -   | 2   | 1   | 2   | 1   |

**AP4202**

**POWER CONVERSION CIRCUITS FOR ELECTRONICS**

**L T P C  
3 0 0 3**

### COURSE OBJECTIVE:

- To provide the students a deep insight in to the working of different switching devices with respect to their characteristics
- To analyze different converters with their applications.
- To study advanced converters and switching techniques implemented in recent technology

### UNIT I

#### **POWER ELECTRONIC DEVICES AND SEMICONDUCTOR SWITCHES**

**9**

Introduction, Applications of power electronics, Power electronics devices: Characteristics of power devices – characteristics of SCR, diac, triac, GTO, PUJT, power transistors – power FETs – LASCR – two transistor model of SCR Protection of thyristors against over voltage – over current, dv/dt and di/dt. Power Semiconductor Switches: Rectifier diodes, fast recovery diodes.

### UNIT II

#### **SCR PERFORMANCE AND APPLICATIONS**

**9**

Turn on circuits for SCR – triggering with single pulse and train of pulses synchronizing with supply – Thyristor turn off methods, natural and forced commutation, self-commutation series and parallel operations of SCRs. Rectifiers: Single phase and three phase controlled Rectifiers with inductive loads, RL load. Construction & Working of Opto- Isolators, Opto-TRIAC, Opto-SCR.

### UNIT III

#### **INVERTERS AND VOLTAGE CONTROLLERS**

**9**

Voltage and current source inverters, resonant, Series inverter, PWM inverter. AC and DC choppers – DC to DC converters – Buck, boost and buck – boost.





Compilation Process – Libraries – Porting kernels – C extensions for embedded systems – emulation and debugging techniques – RTOS – System design using RTOS.

**TOTAL : 45 PERIODS**

### **SUGGESTED ACTIVITIES:**

- 1: Insist students to write a requirements form for a smart phone
- 2: Compare the use of different Microcontrollers for a particular ESD.
- 3: Application of a protocol for a specified application.
- 4: Write a Embedded C code for a given task.
- 5: design an embedded system for any type of real time application

### **PRACTICAL LIST:**

#### Exercise – 1

Comparative study of software development tools and design steps with respect to FPGA based and Non – FPGA based (defined logic) embedded system development.

(For Example: consider any Spartan FPGA board for FPGA based Embedded System Consider any cortex- M based board for Non – FPGA based Embedded system)

#### Exercise – 2

Implement adder and decoder logic blocks in any one of the FPGA chip based development board.

#### Exercise – 3

Design and development of UART protocol logic block in any one of FPGA chip based development board.

#### Exercise – 4

Consider on board LEDS ( any four) and timer logic block of cortex- M board. Write a program which enables LEDS to glow in different timing.

#### Exercise – 5

Consider on board switches and (2x16) LCD display develop a program which displays the status of switch activation.

#### Exercise – 6

Demonstrate GPIO based I/O interfacing by considering LM 35 temperature sensor and cortex- M board.

#### Exercise – 7

Development of one interfacing scheme which transmits data from one cortex- M board to another cortex- M board using on chip CAN logic blocks.

#### Exercise – 8

Consider on board EPROM IC of Cortex- M board by utilizing on chip I2c logic block transmit data to EPROM IC and receive stored data from EPROM IC.

#### Exercise – 9

Consider on board LEDs (4 Nos) of Cortex - M board. Demonstrate time management service concept of RTOS for glowing all four LEDS in different timings.

#### Exercise – 10

Consider two ultrasonic sensors which are interfaced with cortex- M board. Both are located some distance ( 2 meters) apart vertically so that the system can identify the movement of object in term of distance. consider data reception and display of each sensor as two different tasks by RTOS. Establish a RTOS based system to recognize the height of moving object.

Objective:

- Able to understand embedded system design flow in FPGA chip based and Non – FPGA chip based embedded development boards.
- Able to create simple logic blocks in FPGA chip based boards.
- Able to understand interfacing scheme for Non – FPGA board scheme for Non – FPGA board
- Able to utilize RTOS functions for interfacing practice

#### HARDWARE AND SOFTWARE REQUIREMENTS

- Cortex- M board and simulation tools
- FPGA EVM Board and simulation tools
- Ultrasonic sensor
- Any portable open source RTOS

#### COURSE OUTCOMES:

At the end of the course the student will be:

**CO1:** Able to design an Embedded system

**CO2:** Understand a general and single purpose processor

**CO3:** Explain different protocols

**CO4:** Discuss state machine and design process models

**CO5:** Outline embedded software development tools and RTOS

**TOTAL:45+30=75 PERIODS**

#### REFERENCES

- Bruce Powel Douglas, “Real time UML, second edition: Developing efficient objects for embedded systems”, 3rd Edition 1999, Pearson Education.
- Daniel W. Lewis, “Fundamentals of embedded software where C and assembly meet”, Pearson Education, 2002.
- Frank Vahid and Tony Gwargie, “Embedded System Design”, John Wiley & sons, 2002.
- Steve Heath, “Embedded System Design”, Elsevier, Second Edition, 2004

#### CO-PO Mapping

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| <b>1</b>   | 2   | -   | -   | -   | -   | -   |
| <b>2</b>   | -   | -   | 2   | 1   | -   | -   |
| <b>3</b>   | -   | -   | -   | 1   | 2   | -   |
| <b>4</b>   | -   | -   | 2   | -   | 1   | -   |
| <b>5</b>   | -   | -   | -   | -   | 2   | 1   |
| <b>Avg</b> | 2   | -   | 2   | 1   | 2   | 1   |

**COURSE OBJECTIVE:**

- Familiarize with different FPGA boards
- Analyze digital design using Front end Tools
- Analyze the CMOS circuits using CAD tools
- Analyze the interfacing of I/O devices with Arduino Boards using Embedded C

**PRACTICAL EXPERIMENTS:**

1. Synthesize and implement Combinational and Sequential Circuits in VERILOG / VHDL
2. Synthesize and implement MAC unit and GCD unit in Verilog /VHDL
3. Implementation of sampling of input signal and display in FPGA Synthesize and implement FIR filter and IIR filter Verilog /VHDL
4. Synthesize and implement 8 bit general purpose processor in Verilog/VHDL
5. Synthesize and implement UART and USART
6. Simulation and Analysis of CMOS combinational and sequential logic circuits using CAD tools

**TOTAL : 60 PERIODS****COURSE OUTCOME:**

At the end of the course, the students will be able to

**CO1:**Program in Verilog/VHDL for combinational and sequential circuits and implement the program in FPGA

**CO2:**Implement FIR and IIR filters in FPGA

**CO3:**Implement data path design and interfaces

**CO4:**Handle CAD tools to draw/edit, and analyze the CMOS circuits.

**CO5:**Program and interface the Arduino Boards using Embedded C

**CO-PO Mapping**

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1          | 1   | -   | -   | -   | 3   | -   |
| 2          | 2   | -   | -   | -   | 2   | -   |
| 3          | -   | -   | -   | 2   | 1   | -   |
| 4          | 2   | -   | -   | 2   | -   | -   |
| 5          | -   | -   | -   | 2   | 1   | 2   |
| <b>Avg</b> | 2   | -   | -   | 2   | 2   | 2   |

**COURSE OBJECTIVE:**

- To prepare the student to be an entry-level industrial standard ASIC or FPGA designer.
- To analyze the issues and tools related to ASIC/FPGA design and implementation.

- To understand basics of System on Chip and Platform based design.

**UNIT I INTRODUCTION TO ASICs, CMOS LOGIC AND ASIC LIBRARY DESIGN 9**

Types of ASICs - Design flow - CMOS transistors - Combinational Logic Cell – Sequential logic cell -Data path logic cell - Transistors as Resistors - Transistor Parasitic Capacitance- Logical effort.

**UNIT II PROGRAMMABLE ASICs, PROGRAMMABLE ASIC LOGIC CELLS AND PROGRAMMABLE ASIC I/O CELLS 9**

Anti-fuse - static RAM - EPROM and EEPROM technology - Actel ACT - Xilinx LCA –Altera FLEX - Altera MAX DC & AC inputs and outputs - Clock & Power inputs - Xilinx I/O blocks.

**UNIT III PROGRAMMABLE ASIC ARCHITECTURE 9**

Architecture and configuration of Spartan / Cyclone and Virtex / Stratix FPGAs – Micro-Blaze / Niosbased embedded systems – Signal probing techniques.

**UNIT IV LOGIC SYNTHESIS, PLACEMENT AND ROUTING 9**

Logic synthesis - ASIC floor planning- placement and routing – power and clocking strategies.

**UNIT V HIGH PERFORMANCE ALGORITHMS FOR ASICs/ SOCs. SOC CASE STUDIES 9**

DAA and computation of FFT and DCT. High performance filters using delta-sigma modulators. CaseStudies: Digital camera, SDRAM, High speed data standards.

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

At the end of this course students will be able:

- CO1:** To architect ASIC library design
- CO2:** To develop programmable ASIC logic cells
- CO3:** To design I/O cells and interconnects
- CO4:** To understand logic synthesis, placement and routing
- CO5:** To identify new developments in SOC and low power design

**REFERENCES:**

1. Douglas J. Smith, HDL Chip Design, Madison, AL, USA: Doone Publications, 1996.
2. Jose E. France, YannisTsvividis, "Design of Analog - Digital VLSI Circuits forTelecommunication and Signal Processing", Prentice Hall, 1994.
3. M.J.S.Smith, " Application - Specific Integrated Circuits", Pearson,2003.
- 4 Mohammed Ismail and Terri Fiez, "Analog VLSI Signal and Information Processing ", McGraw Hill, 1994.
- 5 Roger Woods, John McAllister, Dr. Ying Yi, Gaye Lightbod, "FPGA-based Implementationof Signal Processing Systems", Wiley, 2008.
- 6 Steve Kilts, "Advanced FPGA Design," Wiley Inter-Science,2007

**CO-PO Mapping**

| CO | POs |     |     |     |     |     |
|----|-----|-----|-----|-----|-----|-----|
|    | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1  | -   | -   | -   | -   | -   | -   |
| 2  | 1   | -   | 1   | 2   | 2   | 2   |
| 3  | 2   | -   | 1   | 3   | 3   | 2   |

|            |   |   |   |   |   |   |
|------------|---|---|---|---|---|---|
| <b>4</b>   | - | - | 2 | 3 | 3 | 2 |
| <b>5</b>   | 1 | - | 3 | 3 | 3 | 1 |
| <b>Avg</b> | 1 | - | 2 | 3 | 3 | 2 |

**AP4071 COMPUTER ARCHITECTURE AND PARALLEL PROCESSING**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES:**

- Discuss the basic concepts and structure of computers.
- Explain the concepts of number representation and arithmetic operations.
- Explain different types of Memory architectures.
- Describe various parallel processing schemes and vector architecture.
- Summarize the Instruction execution stages and Memory hierarchy.

**UNIT I INTRODUCTION TO COMPUTER ORGANIZATION 9**

Architecture and function of general computer system - Basic Operational Concepts, Bus Structures, Software Performance – Memory locations & addresses – Memory operations – Instruction and instruction sequencing – addressing modes – assembly language - System buses, Multi-bus organization

**UNIT II DATA REPRESENTATION 9**

Signed number representation, fixed and floating point representations, character representation. Computer arithmetic - integer addition and subtraction, ripple carry adder, carry look-ahead adder - multiplication - shift-and-add, Booth multiplier, carry save multiplier - Division - non-restoring and restoring techniques, floating point arithmetic.

**UNIT III PROCESSOR ARCHITECTURE AND CONTROL UNIT 9**

A Basic MIPS implementation – Building a Datapath – Control Implementation Scheme – Hardwired control – micro programmed control - Pipelining – Pipelined datapath and control – Handling Data Hazards & Control Hazards – Exceptions. Processor Architecture: Very Long Instruction Word (VLIW) Architecture, Digital Signal Processor Architecture, System on Chip (SoC) architecture, MIPS Processor and programming

**UNIT IV PARALLEL PROCESSING 9**

Parallel processing challenges – Flynn’s classification – Single Instruction Single Data (SISD), Multiple Instruction Multiple Data (MIMD), Single Instruction Multiple Data (SIMD), Single Program Multiple Data (SPMD), and Vector Architectures - Hardware multithreading – Multi-core processors and other Shared Memory Multiprocessors - Introduction to Graphics Processing Units, Clusters, Warehouse Scale Computers and other Message-Passing Multiprocessors.

**UNIT V MEMORY & I/O SYSTEMS 9**

Memory Hierarchy – memory technologies – cache memory – measuring and improving cache performance – virtual memory, Translation Lookaside Buffers – Accessing I/O Devices – Interrupts – Direct Memory Access – Bus structure – Bus operation – Arbitration – Interface circuits – Universal Serial Bus.

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES

Upon completion of this course, the student will be able to

**CO1:** Understand the basic organization of computer and different instruction formats and addressing modes. (K2)

**CO2:** Interpret the representation and manipulation of data on the computer. (K3)

**CO3:** Illustrate about implementation schemes of control unit and pipeline performance. (K2)

**CO4:** Summarize the various types of parallelism architectures. (K2)

**CO5:** Compare the various memory hierarchy and I/O systems. (K2)

## REFERENCES

1. David A. Patterson and John L. Hennessy, "Computer Organization and Design: The Hardware/Software Interface", Morgan Kaufmann / Elsevier, 5th Edition, 2014.
2. Carl Hamacher, Zvonko Vranesic, Safwat Zaky and Naraig Manjikian, "Computer Organization and Embedded Systems", Tata McGraw Hill, 6th Edition, 2012.
3. William Stallings, "Computer Organization and Architecture – Designing for Performance", Pearson Education, 8th Edition, 2010.
4. John P. Hayes, "Computer Architecture and Organization", Tata McGraw Hill, 3rd Edition, 2012.
5. John L. Hennessy and David A. Patterson, "Computer Architecture – A Quantitative Approach", Morgan Kaufmann / Elsevier Publishers, 5th Edition, 2012.

### CO-PO Mapping

| CO  | POs |     |     |     |     |     |
|-----|-----|-----|-----|-----|-----|-----|
|     | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1   | -   | -   | 1   | 2   | -   | 3   |
| 2   | -   | -   | 1   | 2   | 1   | 3   |
| 3   | 1   | -   | 2   | 2   | -   | 2   |
| 4   | -   | -   | 1   | 1   | 1   | 3   |
| 5   | -   | -   | 1   | 1   | 1   | 3   |
| Avg | 1   | -   | 1   | 2   | 1   | 3   |

AP4091

AUTOMOTIVE ELECTRONICS

L T P C  
3 0 0 3

## COURSE OBJECTIVES:

- To explain the principle of electronic management system and different sensors used in the systems.
- To know the concepts and develop basic skills necessary to diagnose automotive electronic problems.
- To know Starting, and charging, lighting systems, advanced automotive electrical systems.
- To include electronic accessories and basic computer control.
- To explore practically about the components present in an Automotive electrical and electronics system.



**CO5:** Describe the principles and architecture of electronics systems and its components present in an automobile related to instrumentation, control, security and warning systems.

**REFERENCES**

1. Allan Bonnick, "Automotive Computer Controlled Systems", Butterworth-Heinemann, Elsevier, 1st Edition, 2011.
2. Eric Chowanietz, "Automobile Electronics" by SAE Publications, 1995
3. Tom Weather Jr and Cland C. Hunter, "Automotive Computers and Control System" Prentice Hall Inc., 1984 New Jersey.
4. R.K. Jurgen, "Automotive Electronics Handbook", McGraw Hill 2nd Edition, 1995.
5. William B Ribbens, "Understanding Automotive Electronics", 5th edition - Butterworth-Heinemann Woburn, 1998.

**CO-PO Mapping**

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1          | -   | -   | 1   | 2   | 2   | 3   |
| 2          | -   | -   | 1   | 3   | -   | 2   |
| 3          | 3   | -   | 3   | 3   | 1   | 2   |
| 4          | -   | -   | 2   | 3   | 3   | 3   |
| 5          | -   | -   | 1   | 3   | 1   | 2   |
| <b>Avg</b> | 3   | -   | 2   | 3   | 1   | 2   |

**AP4094**

**ROBOTICS**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To Introduce the concepts of Robotic systems
- To understand the concepts of Instrumentation and control related to Robotics
- To understand the kinematics and dynamics of robotics
- To explore robotics in Industrial applications

**UNIT I INTRODUCTION TO ROBOTICS**

**9**

Robotics -History - Classification and Structure of Robotic Systems - Basic components -Degrees of freedom - Robot joints coordinates- Reference frames - workspace- Robot languages- Robotic sensors- proximity and range sensors, ultrasonic sensor, touch and slip sensor.

**UNIT II ROBOT KINEMATICS AND DYNAMICS**

**9**

Kinematic Modelling: Translation and Rotation Representation, Coordinate transformation, DH parameters, Forward and inverse kinematics, Jacobian, Dynamic Modelling: Forward and inverse dynamics, Equations of motion using Euler-Lagrange formulation, Newton Euler formulation.

**UNIT III      ROBOTICS CONTROL****9**

Control of robot manipulator - state equations - constant solutions -linear feedback systems, single-axis PID control - PD gravity control -computed torque control, variable structure control and impedance control.

**UNIT IV      ROBOT INTELLIGENCE AND TASK PLANNING****9**

Artificial Intelligence - techniques - search problem reduction - predicate logic means and end analysis -problem solving -robot learning - task planning - basic problems in task planning - AI in robotics and Knowledge Based Expert System in robotics

**UNIT-V      INDUSTRIAL ROBOTICS****9**

Robot cell design and control - cell layouts - multiple robots and machine interference - work cell design - work cell control - interlocks – error detection deduction and recovery - work cell controller - robot cycle time analysis. Safety in robotics, Applications of robot and future scope.

**TOTAL : 45 PERIODS****COURSE OUTCOMES:**

At the end of the course the student will be able to

**CO1:** Describe the fundamentals of robotics

**CO2:** Understand the concept of kinematics and dynamics in robotics.

**CO3:** Discuss the robot control techniques

**CO4:** Explain the basis of intelligence in robotics and task planning

**CO5:** Discuss the industrial applications of robotics

**REFERENCE:**

1. John J. Craig, 'Introduction to Robotics (Mechanics and Control)', Addison-Wesley, 2<sup>nd</sup> Edition, 2004.
2. Richard D. Klafter, Thomas A. Chmielewski, Michael Negin, 'Robotics Engineering: An Integrated Approach', PHI Learning, New Delhi, 2009.
3. K.S.Fu, R.C.Gonzalez and C.S.G.Lee, 'Robotics Control, Sensing, Vision and Intelligence', Tata McGraw Hill, 2<sup>nd</sup> Reprint,2008.
4. Reza N.Jazar, 'Theory of Applied Robotics Kinematics, Dynamics and Control', Springer, 1<sup>st</sup> Indian Reprint, 2010.
5. Mikell. P. Groover, Michell Weis, Roger. N. Nagel, Nicolous G.Odrey, 'Industrial Robotics Technology, Programming and Applications ', McGraw Hill, Int 2012.

**CO-PO Mapping**

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| <b>1</b>   | -   | -   | 1   | 3   | -   | 3   |
| <b>2</b>   | -   | -   | 1   | 3   | -   | 3   |
| <b>3</b>   | -   | -   | 1   | 3   | -   | 3   |
| <b>4</b>   | -   | -   | 1   | 3   | -   | 2   |
| <b>5</b>   | 2   | -   | 1   | 3   | -   | 3   |
| <b>Avg</b> | 2   | -   | 1   | 3   | -   | 3   |

**COURSE OBJECTIVE:**

- To classify various soft computing frame works.
- To be familiar with the design of neural networks, fuzzy logic, and fuzzy systems.
- To learn mathematical background for optimized genetic programming.
- Be exposed to neuro-fuzzy hybrid systems and its applications.
- To understand the various evolutionary optimization techniques.

**UNIT I FUZZY LOGIC:****9**

Introduction to Fuzzy logic - Fuzzy sets and membership functions- Operations on Fuzzy sets- Fuzzy relations, rules, propositions, implications, and inferences- Defuzzification techniques- Fuzzy logic controller design- Some applications of Fuzzy logic.

**UNIT II ARTIFICIAL NEURAL NETWORKS:****9**

Supervised Learning: Introduction and how brain works, Neuron as a simple computing element, The perceptron, Backpropagation networks: architecture, multilayer perceptron, backpropagation learning-input layer, accelerated learning in multilayer perceptron, The Hopfield network, Bidirectional associative memories (BAM), RBF Neural Network.  
 Unsupervised Learning: Hebbian Learning, Generalized Hebbian learning algorithm, Competitive learning, Self- Organizing Computational Maps: Kohonen Network.

**UNIT III GENETIC ALGORITHM:****9**

Genetic algorithm- Introduction - biological background - traditional optimization and search techniques - Genetic basic concepts - operators – Encoding scheme – Fitness evaluation – crossover - mutation - Travelling Salesman Problem, Particle swarm optimization, Ant colony optimization.

**UNIT IV NEURO-FUZZY MODELING****9**

Adaptive Neuro-Fuzzy Inference Systems (ANFIS) – architecture - Coactive Neuro-Fuzzy Modeling, framework, neuron functions for adaptive networks – Data Clustering Algorithms – Rule base Structure Identification –Neuro-Fuzzy Control – the inverted pendulum system.

**UNIT V CONVENTIONAL OPTIMIZATION TECHNIQUES****9**

Introduction to optimization techniques, Statement of an optimization problem, classification, Unconstrained optimization-gradient search method-Gradient of a function, steepest gradient-conjugate gradient, Newton's Method, Marquardt Method, Constrained optimization –sequential linear programming, Interior penalty function method, external penalty function method.

**TOTAL :45 PERIODS****COURSE OUTCOMES:**

Upon Completion of the course, the students will be able to:

- CO1:**Develop application on different soft computing techniques like Fuzzy, GA and Neural network
- CO2:**Implement Neuro-Fuzzy and Neuro-Fuzz-GA expert system.
- CO3:**Implement machine learning through Neural networks.
- CO4:**Model Neuro Fuzzy system for clustering and classification.
- CO5:**Able to use the optimization techniques to solve the real world problems

**REFERENCES:**

1. J.S.R.Jang, C.T. Sun and E.Mizutani, Neuro-Fuzzy and Soft Computing, PHI / Pearson Education 2004.
2. David E. Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Addison wesley, 2009.
3. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic-Theory and Applications,Prentice Hall, 1995.
4. James A. Freeman and David M. Skapura, Neural Networks Algorithms, Applications, and Programming Techniques, Pearson Edn., 2003.
5. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, Neuro-Fuzzy and Soft Computing, Prentice-Hall of India, 2003.
6. Mitchell Melanie, An Introduction to Genetic Algorithm, Prentice Hall, 1998.
7. Simon Haykins, Neural Networks: A Comprehensive Foundation, Prentice Hall International Inc, 1999.
8. Timothy J.Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, 1997.

**CO-PO Mapping**

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1          | 3   | -   | 3   | 1   | 3   | 1   |
| 2          | 3   | -   | 3   | 1   | 3   | 1   |
| 3          | 3   | -   | 3   | 1   | 3   | 1   |
| 4          | 3   | -   | 3   | 1   | 3   | 1   |
| 5          | 3   | -   | 3   | 1   | 3   | 1   |
| <b>Avg</b> | 3   | -   | 3   | 1   | 3   | 1   |

**CU4251****RF SYSTEM DESIGN****L T P C  
3 0 0 3****COURSE OBJECTIVES:**

- Be familiar with RF transceiver system design for wireless communications
- Be exposed to design methods of receivers and transmitters used in communication systems
- Design RF circuits and systems using an advanced design tool.
- Exemplify different synchronization methods circuits and describe their block schematic and design criteria
- Measure RF circuits and systems with a spectrum analyzer.

**UNIT I BASICS OF RADIO FREQUENCY SYSTEM DESIGN****9**

Definitions and models of Linear systems and Non-linear system. Specification parameters: Gain, noise figure, SNR, Characteristic impedance, S-parameters, Impedance matching and Decibels. Elements of digital base band signalling: complex envelope of band pass signals, Average value, RMS value, Crest factor, Sampling, jitter, modulation techniques, filters, pulse shaping, EVM, BER,

sensitivity, selectivity, dynamic range and, adjacent and alternate channel power leakages

**UNIT II RADIO ARCHITECTURES AND DESIGN CONSIDERATIONS 9**

Superheterodyne architecture, direct conversion architecture, Low IF architecture, band-pass sampling radio architecture, System Design Considerations for an Analog Frontend Receiver in Cognitive Radio Applications, Interference, Near, In-band & wide-band considerations.

**UNIT III AMPLIFIER MODELING AND ANALYSIS 9**

Noise: Noise equivalent model for Radio frequency device, amplifier noise model, cascade performance, minimum detectable signal, performance of noisy systems in cascade. Non-Linearity: Amplifier power transfer curve, gain compression, AM-AM, AM-PM, polynomial approximations, Saleh model, Wiener model and Hammerstein model, intermodulation, Single and two tone analyses, second and third order distortions and measurements, SOI and TOI points, cascade performance of nonlinear systems.

**UNIT IV MIXER AND OSCILLATOR MODELING AND ANALYSIS 9**

Mixers: Frequency translation mechanisms, frequency inversion, image frequencies, spurious calculations, principles of mixer realizations. Oscillators: phase noise and its effects, effects of oscillator spurious components, frequency accuracy, oscillator realizations: Frequency synthesizers, NCO.

**UNIT V APPLICATIONS OF SYSTEMS DESIGN 9**

Multimode and multiband Superheterodyne transceiver: selection of frequency plan, receiver system and transmitter system design – Direct conversion transceiver: receiver system and transmitter system design.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

**Upon the completion of course, students will be able to**

**CO1:** understand the specifications of transceiver modules

**CO2:** understand pros and cons of transceiver architectures and their associated design considerations

**CO3:** understand the impact of noise and amplifier non-linearity of amplification modules and also will learn the resultant effect during cascade connections

**CO4:** get exposure about spurs and generation principles during signal generation and frequency translations

**CO5:** understand the case study of transceiver systems and aid to select specification parameters

**REFERENCES**

1. The Design of CMOS Radio-Frequency Integrated Circuits by Thomas H. Lee. Cambridge University Press, 2004.
2. Qizheng Gu, "RF System Design of Transceivers for Wireless Communications", Springer ,2005.
3. Kevin McClaning, "Wireless Receiver Design for Digital Communications," Yes Dee Publications, 2012.
4. M C Jeruchim, P Balapan and K S Shanmugam, "Simulation of Communication systems:Modeling, Methodology and Techniques", Kluwer Academic/Plenum Publishers, 2 nd Edition, 2000.

### CO-PO Mapping

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1          | -   | -   | 2   | 1   | -   | 3   |
| 2          | 3   | -   | 2   | 1   | -   | 3   |
| 3          | -   | -   | 2   | 1   | -   | 3   |
| 4          | -   | -   | 3   | 1   | -   | 3   |
| 5          | 3   | -   | 3   | 1   | -   | 3   |
| <b>Avg</b> | 3   | -   | 3   | 1   | -   | 3   |

**EL4071                      ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY                      L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To gain broad conceptual understanding of the various aspects of electromagnetic (EM) interference and compatibility
- To develop a theoretical understanding of electromagnetic shielding effectiveness
- To understand ways of mitigating EMI by using shielding, grounding and filtering
- To understand the need for standards and to appreciate measurement methods
- To understand how EMI impacts wireless and broadband technologies

**UNIT I                      INTRODUCTION & SOURCES OF EM INTERFERENCE                      9**  
 Introduction - Classification of sources - Natural sources - Man-made sources - Survey of the electromagnetic environment.

**UNIT II                      EM SHIELDING                      9**  
 Introduction - Shielding effectiveness - Far-field sources - Near-field sources - Low-frequency, magnetic field shielding - Effects of apertures

**UNIT III                      INTERFERENCE CONTROL TECHNIQUES                      9**  
 Equipment screening - Cable screening - grounding - Power-line filters - Isolation - Balancing - Signal-line filters - Nonlinear protective devices.

**UNIT IV                      EMC STANDARDS, MEASUREMENTS AND TESTING                      9**  
 Need for standards - The international framework - Human exposure limits to EM fields -EMC measurement techniques - Measurement tools - Test environments.

**UNIT V                      EMC CONSIDERATIONS IN WIRELESS AND BROADBAND TECHNOLOGIES                      9**  
 Efficient use of frequency spectrum - EMC, interoperability and coexistence - Specifications and alliances - Transmission of high-frequency signals over telephone and power networks – EMC and digital subscriber lines - EMC and power line telecommunications.

**SUGGESTED ACTIVITIES:**

1. Investigate various case studies related to EMIC. Example: Chernobyl Disaster in 1986.
2. Develop some understanding about the design of EM shields in electronic system design and packaging.

**COURSE OUTCOMES:**

Upon completion of this course, the student will be able to

**CO1:**Demonstrate knowledge of the various sources of electromagnetic interference

**CO2:**Display an understanding of the effect of how electromagnetic fields couple through apertures, and solve simple problems based on that understanding

**CO3:**Explain the EMI mitigation techniques of shielding and grounding

**CO4:**Explain the need for standards and EMC measurement methods

**CO5:**Discuss the impact of EMC on wireless and broadband technologies

**TOTAL:45 PERIODS**

**REFERENCES**

1. Christopoulos C, Principles and Techniques of Electromagnetic Compatibility, CRC Press, Second Edition, Indian Edition, 2013.
2. Paul C R, Introduction to Electromagnetic Compatibility, Wiley India, Second Edition,2008.
3. Kodali V P, Engineering Electromagnetic Compatibility, Wiley India, Second Edition,2010.
4. Henry W Ott, Electromagnetic Compatibility Engineering, John Wiley & Sons Inc, Newyork,2009.
5. Scott Bennett W, Control and Measurement of Unintentional Electromagnetic Radiation, John Wiley& Sons Inc., Wiley Interscience Series, 1997.

**CO-PO Mapping**

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1          | -   | -   | 1   | -   | -   | 3   |
| 2          | -   | -   | 1   | -   | -   | 2   |
| 3          | -   | -   | 1   | -   | -   | 3   |
| 4          | -   | -   | 1   | -   | 2   | 3   |
| 5          | -   | -   | 1   | -   | -   | 3   |
| <b>Avg</b> | -   | -   | 1   | -   | 2   | 3   |

**AP4003**

**VLSI DESIGN TECHNIQUES**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand the basics I-V characteristics of MOS transistor
- To introduce the VLSI design flow
- To Design combinational and sequential circuits
- To introduce testing of VLSI circuits
- To explore system design using Verilog HDL

- Unit I CMOS TECHNOLOGY 9**  
MOS transistor, Ideal I–V characteristics, C–V characteristics, non-ideal I–V effects – CMOS Inverter and Pass transistor DC transfer characteristics – CMOS technologies, Layout design Rules – Stick Diagram – CMOS process enhancements– VLSI design Flow.
- Unit II CIRCUIT DELAY,POWER, INTERCONNECT AND VERILOG HDL 9**  
Delay estimation – Logical effort and Transistor sizing – Power dissipation – Interconnect – Design margin –Reliability – Scaling – SPICE – Device models.  
Verilog: Procedural assignments –conditional statements – Design of combinational and sequential circuits using different types of modeling –Test benches.
- Unit III COMBINATIONAL AND SEQUENTIAL CIRCUIT DESIGN 9**  
Circuit families –Circuit Pitfalls – Sequencing static circuits, Max-min delay constraints, Time borrowing, Clock Skew – circuit design of latches and flip flops – synchronizers, Metastability, communication between asynchronous clock domains.
- Unit IV CMOS TESTING 9**  
Need for testing – Testers, Text fixtures and test programs – Logic verification – Silicon debug principles –Manufacturing test – Design for testability – Boundary scan test.
- UNIT V SYSTEM DESIGN USING VERILOG HDL 9**  
Basic concepts- identifiers- gate primitives- gate delays- operators timing controls- procedural assignments-conditional statements- Design of combinational and sequential circuits using Data flow- structural gate level- switch level modeling and Behavioral modeling-Test benches.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

After the completion of the course the students will be able to,

- CO1:** Analyze the characteristics of CMOS transistor  
**CO2:** Identify the methods to distribute clock and reduce power dissipation in CMOS circuits.  
**CO3:** Design combinational and sequential circuits  
**CO4:** Analyze the methods to test the CMOS circuits  
**CO5:** Synthesize the combinational and sequential circuits using Verilog HDL

**REFERENCES:**

1. Weste and Harris: "CMOS VLSI DESIGN" 4th Edition, Pearson Education, 2013
2. Uyemura J.P: "Introduction to VLSI circuits and systems", Wiley 2002.
3. D.APucknell&K.Eshraghian, "Basic VLSI Design", 3rd Edition, PHI, 2003
4. Wayne Wolf, "Modern VLSI design", 4th edition Pearson Education, 2009
5. M.J.S.Smith, "Application specific integrated circuits", 1st edition, Addison-Wesley Professional,1997
6. Ciletti, "Advanced Digital Design with the Verilog HDL", 2nd edition, Pearson Education 2010
7. Samir Palnitkar "Verilog HDL a guide to digital design and Synthesis", Prentice Hall, 2nd edition, 2003

### CO-PO Mapping

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1          | -   | -   | 1   | 2   | -   | 3   |
| 2          | 1   | -   | 2   | 1   | -   | 2   |
| 3          | 2   | -   | 1   | 2   | 1   | 3   |
| 4          | -   | -   | 1   | 2   | 1   | 2   |
| 5          | 1   | -   | 1   | 2   | 3   | 3   |
| <b>Avg</b> | 1   | -   | 1   | 2   | 1   | 3   |

**AP4004**

**NANO TECHNOLOGIES**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To introduce the basics of nano electronics
- To understand the basics of semiconductor materials
- To understand the basics of MOSFETS and its application in nano electronics
- To learn the advanced nanoscale devices
- To explore about Biosensors

**UNIT I INTRODUCTION TO NANOELECTRONICS**

**9**

Introduction to nanoelectronics, Limitations of conventional microelectronics. Classical Particles, Classical Waves and Quantum Particles-Quantum Mechanics of Electronics -Schrödinger wave equation.

**UNIT II MATERIALS FOR NANOELECTRONICS**

**9**

Introduction- Semiconductors, Crystal lattices: Bonding in crystals- Electron energy bands- Semiconductor heterostructures-Lattice-matched and pseudomorphic heterostructures-Carbon nanomaterials: nanotubes and fullerenes.

**UNIT III SHRINK-DOWN APPROACHES**

**9**

Moore's Law- Technology Scaling and Reliability Challenges. Basic MOS Transistor-Types, Modes of operation, n-MOS operation, Drain Current, Threshold Voltage, Energy band diagram of MOSFET, nanoscale MOSFET, SCEs-limits to scaling, system integration limits.

**UNIT IV ADVANCED NANOSCALE DEVICES**

**9**

Double Gate MOSFETs, Tri-Gate MOSFETs, Tunnel FETs-Multi-Gate TFETs and Heterojunction TFETs- Graphene and Carbon Nanotube Transistors.

**UNIT V FET BASED BIOSENSORS**

**9**

Principles- Components of biosensor-Classification of Biosensors based on transducers, FET based Biosensor- ion-sensitive field effect transistor-operation and fabrication-Characteristics and Performance.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

**CO1:** Understand the basic concepts of nano electronics and various aspects of nano electronics. (K2)

**CO2:** Summarize the basic knowledge of Semiconductor materials and carbon nano tubes. (K2)

**CO3:** Understand the basic concepts of MOS scaling. (K2)

**CO4:** understand the advanced nanoscale devices (K3)

**CO5:** Understand the Bio sensor devices. (K2)

**REFERENCES**

1. G.W. Hanson, Fundamentals of Nanoelectronics, Pearson, 2009.
2. Vladimir V. Mitin, Viatcheslav A. Kochelap, Michael A. Stroscio, "Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications", Cambridge University Press 2011.
3. Pierre R. Coulet, Loïc J. Blum, Biosensor Principles and Applications, CRC press-2019.
4. Donald A. Neamen, "Semiconductor Physics and Devices Basic Principles", Third Edition, McGraw-Hill Higher- Education, 2003.

**CO-PO Mapping**

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| <b>1</b>   | -   | -   | 1   | 3   | -   | 3   |
| <b>2</b>   | 1   | -   | 2   | 2   | -   | 2   |
| <b>3</b>   | 2   | -   | 1   | 2   | 1   | 3   |
| <b>4</b>   | -   | -   | 1   | 3   | 1   | 2   |
| <b>5</b>   | 1   | -   | 1   | 2   | 3   | 3   |
| <b>Avg</b> | 1   | -   | 1   | 3   | 1   | 3   |

**VL4252****VLSI TESTING****L T P C****3 0 0 3****COURSE OBJECTIVES:**

- to introduce the VLSI testing.
- to introduce logic and fault simulation and testability measures
- to study the test generation for combinational and sequential circuits
- to study the design for testability.
- to study the fault diagnosis

**UNIT I INTRODUCTION TO TESTING****9**

Introduction – VLSI Testing Process and Test Equipment – Challenges in VLSI Testing - Test Economics and Product Quality – Fault Modeling – Relationship Among Fault Models.

**UNIT II LOGIC & FAULT SIMULATION & TESTABILITY MEASURES****9**

Simulation for Design Verification and Test Evaluation – Modeling Circuits for Simulation – Algorithms for True Value and Fault Simulation – Scoap Controllability and Observability

**UNIT III TEST GENERATION FOR COMBINATIONAL AND SEQUENTIAL CIRCUITS 9**

Algorithms and Representations – Redundancy Identification – Combinational ATPG Algorithms – Sequential ATPG Algorithms – Simulation Based ATPG – Genetic Algorithm Based ATPG

**UNIT IV DESIGN FOR TESTABILITY 9**

Design for Testability Basics – Testability Analysis - Scan Cell Designs – Scan Architecture – Built-in Self-Test – Random Logic Bist – DFT for Other Test Objectives.

**UNIT V FAULT DIAGNOSIS 9**

Introduction and Basic Definitions – Fault Models for Diagnosis – Generation of Vectors for Diagnosis – Combinational Logic Diagnosis - Scan Chain Diagnosis – Logic BIST Diagnosis.

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

At the end of this course, the students will be able to:

**CO1:**Understand VLSI Testing Process

**CO2:**Develop Logic Simulation and Fault Simulation

**CO3:**Develop Test for Combinational and Sequential Circuits

**CO4:**Understand the Design for Testability

**CO5:**Perform Fault Diagnosis.

**REFERENCES**

1. Laung-Terng Wang, Cheng-Wen Wu and Xiaoqing Wen, “VLSI Test Principles and Architectures”, Elsevier, 2017
2. Michael L. Bushnell and Vishwani D. Agrawal, “Essentials of Electronic Testing for Digital, Memory & Mixed-Signal VLSI Circuits” , Kluwer Academic Publishers, 2017.
3. Niraj K. Jha and Sandeep Gupta, “Testing of Digital Systems”, Cambridge University Press, 2017.

**CO-PO Mapping**

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1          | -   | -   | 1   | 2   | -   | 3   |
| 2          | 1   | -   | 2   | 1   | 3   | 2   |
| 3          | 2   | -   | 1   | 2   | 1   | 3   |
| 4          | -   | -   | 1   | 2   | 2   | 2   |
| 5          | 1   | -   | 2   | 2   | -   | 3   |
| <b>Avg</b> | 1   | -   | 1   | 2   | 2   | 3   |

**AP4092**

**EDGE ANALYTICS AND INTERNET OF THINGS**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- To Understand the basis for intersection of IOT and Edge Analytics
- To Understand the IOT protocols and standards

- To comprehend the use of Machine Learning in Edge Analytics
- To gain understanding on the use of Deep Learning techniques for analytics
- To gain insight into edge analytics models and deployment

**UNIT I INTRODUCTION TO IOT 9**

Importance and Need for IoT - Application and Use cases of IoT - Overview of Industrial IoT - Intersection of IoT and Edge Analytics.

**UNIT II IOT PROTOCOLS AND SYSTEMS 9**

IoT protocols and standards - Cloud IoT Infrastructure - Setup and program IoT device- Data Collection from IoT device.

**UNIT III MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE 9**

Introduction to Machine Learning and Artificial Intelligence - Overview of Deep Learning and Neural Networks- Introduction to Convolution Neural Networks.

**UNIT IV AUTO ENCODERS AND ITS PROGRAMMING 9**

Introduction to Recurrent Neural Networks- Introduction to Auto Encoders- Programming Practice: Build Image Classifier, Build Anomaly Detector

**UNIT V EDGE ANALYTICS 9**

Challenges with Edge Devices and Deployment - Need for Model Quantization Quantization Aware Training- Post Model Quantization- Programming Practice: Model quantization, Deploying model on Edge Devices

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, student will be able to

**CO 1:** Use the foundational concepts in Edge Analytics for application design and development

**CO 2:** Use IOT protocols in cloud environments.

**CO 3:** Implement and use Machine Learning and Artificial Intelligence algorithms and tools

**CO 4:** implement and use Deep Learning techniques for applications

**CO 5:** Analyze Edge devices analytics models and and its challenges

**REFERENCES:**

1. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press, 2012.
2. P. Flach, "Machine learning: The art and science of algorithms that make sense of datall, Cambridge University Press, 2012.
3. Anirudh Koul, Siddha Ganju, Meher Kasam, "Practical Deep Learning for Cloud, Mobile, and Edge" O'Reilly Media, 2019.
4. Dieter Uckelmann, Mark Harrison, Florian Michahelles, "Architecting the Internet of Things", Springer, 2011.

**CO-PO Mapping**

| CO | POs |     |     |     |     |     |
|----|-----|-----|-----|-----|-----|-----|
|    | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1  | -   | -   | 1   | 2   | -   | 3   |

|            |   |   |   |   |   |   |
|------------|---|---|---|---|---|---|
| 2          | 1 | - | 2 | 1 | 3 | 2 |
| 3          | 2 | - | 1 | 2 | 3 | 3 |
| 4          | - | - | 1 | 2 | 3 | 2 |
| 5          | 1 | - | 1 | 2 | 2 | 3 |
| <b>Avg</b> | 1 | - | 1 | 2 | 3 | 3 |

**AP4093**

**QUANTUM COMPUTING**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To introduce the building blocks of Quantum computers and highlight the paradigm change between conventional computing and quantum computing
- To understand the Quantum state transformations and the algorithms
- To understand entangled quantum subsystems and properties of entangled states
- To explore the applications of quantum computing

**UNIT I QUANTUM BUILDING BLOCKS 9**

The Quantum Mechanics of Photon Polarization, Single-Qubit Quantum Systems, Quantum State Spaces, Entangled States, Multiple-Qubit Systems, Measurement of Multiple-Qubit States, EPR Paradox and Bell's Theorem, Bloch sphere

**UNIT II QUANTUM STATE TRANSFORMATIONS 9**

Unitary Transformations, Quantum Gates, Unitary Transformations as Quantum Circuits, Reversible Classical Computations to Quantum Computations, Language for Quantum Implementations.

**UNIT III QUANTUM ALGORITHMS 9**

Computing with Superpositions, Quantum Subroutines, Quantum Fourier Transformations, Shor's Algorithm and Generalizations, Grover's Algorithm and Generalizations

**UNIT IV ENTANGLED SUBSYSTEMS AND ROBUST QUANTUM COMPUTATION 9**

Quantum Subsystems, Properties of Entangled States, Quantum Error Correction, Graph states and codes, CSS Codes, Stabilizer Codes, Fault Tolerance and Robust Quantum Computing

**UNIT V QUANTUM INFORMATION PROCESSING 9**

Limitations of Quantum Computing, Alternatives to the Circuit Model of Quantum Computation, Quantum Protocols, Building Quantum, Computers, Simulating Quantum Systems, Bell states. Quantum teleportation. Quantum Cryptography, no cloning theorem

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, the student will be able to

**CO1:** Understand the basic principles of quantum computing.

**CO2:** Gain knowledge of the fundamental differences between conventional computing and quantum computing.

**CO3:** Understand several basic quantum computing algorithms.

**CO4:** Understand the classes of problems that can be expected to be solved well by quantum computers.

**CO5:** Simulate and analyze the characteristics of Quantum Computing Systems.

**REFERENCES:**

1. John Gribbin, Computing with Quantum Cats: From Colossus to Qubits, 2021
2. William (Chuck) Easttom, Quantum Computing Fundamentals, 2021
3. Parag Lala, Quantum Computing, 2019
4. Eleanor Rieffel and Wolfgang Polak, QUANTUM COMPUTING A Gentle Introduction, 2011
5. Nielsen M. A., Quantum Computation and Quantum Information, Cambridge University Press.2002
6. Benenti G., Casati G. and Strini G., Principles of Quantum Computation and Information, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics, World Scientific. 2004
7. Pittenger A. O., An Introduction to Quantum Computing Algorithms 2000

**CO-PO Mapping**

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1          | -   | -   | 2   | -   | 1   | -   |
| 2          | 1   | -   | -   | -   | 2   | -   |
| 3          | -   | -   | -   | 2   | -   | 2   |
| 4          | -   | -   | 3   | 1   | -   | -   |
| 5          | -   | 2   | -   | -   | 2   | -   |
| <b>Avg</b> | 1   | 2   | 3   | 2   | 2   | 2   |

**CU4076**

**VLSI FOR WIRELESS COMMUNICATION**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand the concepts of basic wireless communication concepts.
- To study the parameters in receiver and low noise amplifier design.
- To study the various types of mixers designed for wireless communication.
- To study and design PLL and VCO.
- To understand the concepts of transmitters and power amplifiers in wireless communication.

**UNIT I COMMUNICATION CONCEPTS**

**9**

Introduction – Overview of Wireless systems – Standards – Access Methods – Modulation schemes – Classical channel – Wireless channel description – Path loss – Multipath fading – Standard Translation.

**UNIT II RECEIVER ARCHITECTURE & LOW NOISE AMPLIFIERS**

**9**

Receiver front end – Filter design – Non-idealities – Design parameters – Noise figure & Input intercept point. LNA Introduction – Wideband LNA design – Narrow band LNA design: Impedance matching & Core amplifier.

**UNIT III MIXERS 9**

Balancing Mixer - Qualitative Description of the Gilbert Mixer - Conversion Gain – Distortion – Noise - A Complete Active Mixer. Switching Mixer – Distortion, Conversion Gain & Noise in Unbalanced Switching Mixer - A Practical Unbalanced Switching Mixer. Sampling Mixer - Conversion Gain, Distortion, Intrinsic & Extrinsic Noise in Single Ended Sampling Mixer.

**UNIT IV FREQUENCY SYNTHESIZERS 9**

PLL – Phase detector – Dividers – Voltage Controlled Oscillators – LC oscillators – Ring Oscillators – Phase noise – Loop filters & design approaches – A complete synthesizer design example (DECT) – Frequency synthesizer with fractional divider.

**UNIT V TRANSMITTER ARCHITECTURES & POWER AMPLIFIERS 9**

Transmitter back end design – Quadrature LO generator – Power amplifier design.

**COURSE OUTCOMES:**

At the end of this course, the student should be able to

**CO1:** Able to recollect basic wireless communication concepts.

**CO2:** To understand the parameters in receiver and design a low noise amplifier

**CO3:** In a position to apply his knowledge on various types of mixers designed for wireless communication.

**CO4:** Design PLL and VCO

**CO5:** Understand the concepts of transmitters and utilize the power amplifiers in wireless communication.

**TOTAL : 45 PERIODS**

**REFERENCES**

1. Bosco H Leung “VLSI for Wireless Communication”, Pearson Education, 2002.
2. B.Razavi, ”RF Microelectronics” , Prentice-Hall ,1998.
3. Behzad Razavi, “Design of Analog CMOS Integrated Circuits” McGraw-Hill, 1999.
4. Emad N Farag and Mohamed I Elmasry, “Mixed Signal VLSI wireless design – Circuits & Systems”, Kluwer Academic Publishers, 2000.
5. J. Crols and M. Steyaert, “CMOS Wireless Transceiver Design,” Boston, Kluwer Academic Pub., 1997.
6. Thomas H.Lee, “The Design of CMOS Radio – Frequency Integrated Circuits”, Cambridge University Press ,2003.

**CO-PO Mapping**

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| <b>1</b>   | -   | -   | 2   | 2   | -   | -   |
| <b>2</b>   | -   | -   | -   | -   | 3   | 2   |
| <b>3</b>   | -   | -   | 2   | -   | -   | 1   |
| <b>4</b>   | -   | -   | -   | 1   | 2   | -   |
| <b>5</b>   | -   | -   | -   | -   | 2   | 2   |
| <b>Avg</b> | -   | -   | 2   | 2   | 2   | 2   |

**COURSE OBJECTIVES:**

- To understand the operation of sensors and actuators
- To understand the operation of major classes of MEMS devices/systems
- To give the fundamentals of standard micro fabrication techniques and processes
- To understand the unique demands, environments and applications of MEMS devices
- To understand RF MEMS, Bio MEMS and MOEMS

**UNIT I INTRODUCTION TO MEMS****9**

Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Micro fabrication - Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Stress and strain analysis – Flexural beam bending- Torsional deflection.

**UNIT II SENSORS AND ACTUATORS****9**

Electrostatic sensors – Parallel plate capacitors – Applications – Interdigitated Finger capacitor- Piezoresistive sensors – Piezoresistive sensor materials - piezoelectric effects – piezoelectric materials-Stress analysis of mechanical elements – Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph - Applications – Magnetic Actuators – Micromagnetic components.

**UNIT III MICROMACHINING****9**

Silicon Anisotropic Etching – Anisotropic Wet Etching – Dry Etching of Silicon – Plasma Etching – Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies –Basic surface micro machining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch – Striction and Antistrication methods – LIGA Process - Assembly of 3D MEMS – Foundry process.

**UNIT IV POLYMER AND OPTICAL MEMS****9**

Polymers in MEMS – SU-8, PMMA, PDMS, Langmuir – Blodgett Films, Micro System fabrication – Photolithography – Ion implantation- Diffusion – Oxidation – Chemical vapour deposition – Etching- Optical MEMS – Lenses and Mirrors – Actuators for Active Optical MEMS.

**UNIT V OVERVIEW OF MEMS AREAS****9**

Bonding techniques for MEMS : Surface bonding , Anodic bonding , Silicon - on - Insulator , wire bonding , Sealing – Assembly of micro systems- RF MEMS - switches, active and passive components, Bio MEMS - Microfluidics, Digital Micro fluidics, Ink jet printer,- MOEMS - optical switch, optical cross-connect, tunable VCSEL, micro bolometers.

**TOTAL : 45 PERIODS****SUGGESTED ACTIVITIES:**

1. Expose the students to occupational environment related to semiconductor devices and MEMS
2. Create opportunity for acquiring practical skills of various field instruments in the area of

MEMS devices

3. Manage the issues arising during the execution of projects related to MEMS.

**COURSE OUTCOMES:**

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

- CO1:** Understand the working principles of micro sensors and actuators
- CO2:** Understand the application of scaling laws in the design of micro systems
- CO3:** Understand the typical materials used for fabrication of micro machines
- CO4:** Understand the principles of standard micro fabrication techniques
- CO5:** Appreciate the challenges in the design and fabrication of RF, Bio, and MOEMS systems

**REFERENCES**

1. Stephen D Senturia, ‘Microsystem Design’, Springer Publication, 2000.
2. Chang Liu, ‘Foundations of MEMS’, Pearson Education Inc., 2012.
3. Marc J. Madou, ‘Fundamentals of Microfabrication: The Science of Miniaturization’, Second Edition , 2002.
4. Nadim Maluf, “ An Introduction to Micro Electro Mechanical System Design”, Artech House, 2000.
5. Mohamed Gad-el-Hak, editor, “ The MEMS Handbook”, CRC press Baco Raton, 2001.

**CO-PO Mapping**

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| <b>1</b>   | -   | -   | 2   | 1   | -   | -   |
| <b>2</b>   | -   | -   | 2   | -   | -   | 2   |
| <b>3</b>   | 2   | -   | -   | -   | -   | -   |
| <b>4</b>   | -   | 1   | 1   | -   | -   | -   |
| <b>5</b>   | -   | -   | -   | 1   | -   | 3   |
| <b>Avg</b> | 2   | 1   | 2   | 1   | -   | 3   |

**AP4006**

**HARDWARE SECURE COMPUTING**

**L T P C  
3 0 0 3**

**COURSE OBJECTIVES**

- Describe the fundamental principles in Data security
- Discuss the watermarking algorithms and its usage
- Explain the physical attacks and Modular arithmetic security methods
- Describe the memory based attacks and vulnerabilities using deceptive mechanisms
- Discuss the methods of FPGA implementation of cryptographic algorithms

|  |  |                           |
|--|--|---------------------------|
| <b>UNIT I</b>  | <b>INTRODUCTION TO CRYPTO ALGORITHMS</b>           | <b>9</b>                  |
| Cryptography basics, Cryptographic algorithms - Symmetric Key algorithms, Public Key algorithms and Hash Algorithms, Data Encryption Standards, Advanced Encryption Standards, RSA, BowFish  |  |                           |
| <b>UNIT II</b>   | <b>DESIGN INTELLECTUAL PROPERTY PROTECTION</b>     | <b>9</b>                  |
| Introduction to IP Protection, Watermarking Basics, Watermarking Examples, Good Watermarks, Fingerprinting, Hardware Metering.   |  |                           |
| <b>UNIT III</b>  | <b>PHYSICAL ATTACKS AND MODULAR EXPONENTIATION</b> | <b>9</b>                  |
| Physical Attacks (PA) Basics, Physical Attacks and Countermeasures, Building Secure Systems, Modular Exponentiation (ME) Basics, ME in Cryptography, ME Implementation and Vulnerability, Montgomery Reduction.  |  |                           |
| <b>UNIT IV</b>   | <b>ATTACKS AND COUNTER MEASURES</b>                | <b>9</b>                  |
| Introduction to Side Channel Attacks, Memory Vulnerabilities and Cache Attacks, Power Analysis, More Attacks and Countermeasures, Modified Modular Exponentiation, Hardware Trojan (HT) and Trusted IC, Hardware Trojan Taxonomy, Hardware Trojan Detection Overview, Hardware Trojan Detection Methods, Trusted IC Design with HT Prevention. |  |                           |
| <b>UNIT V</b>  | <b>EMERGING TECHNOLOGIES</b>                       | <b>9</b>                  |
| FPGA Implementation of Crypto algorithms, Vulnerabilities and Countermeasures in FPGA Systems, Role of Hardware in Security and Trust, Physical Unclonable Functions (PUF) Basics, Reliability, Trust Platform Modules   |  |                           |
|  |  | <b>TOTAL : 45 PERIODS</b> |

**COURSE OUTCOMES**

Upon completion the students will be able to

- CO1:** Understand the basics of Cryptography(K2)
- CO2:** Identify the mechanism of Data Integrity protection mechanisms(K2)
- CO3:** Analyse the counter measures for physical attacks and the use of Modular exponentiation(K2)
- CO4:** Study side channel attacks and Trojan-based attacks(K2)
- CO5:** Challenges in Realisation using VLSI implementations(K2)

**REFERENCES:**

1. Debdeep Mukhopadhyay and Rajat Subhra Chakraborty, Hardware Security: Design, Threats, and Safeguards, CRC Press,2014
2. Tehranipoor, Mohammad, Wang, Introduction to Hardware Security and Trust, Springer,2011.
3. Ted Huffmire, Handbook of FPGA Design Security, Springer,2010.
4. Stefan Mangard, Elisabeth Oswald, Thomas Popp, Power Analysis Attacks - Revealing the Secrets of Smart Cards, Springer,2007.
5. Doug Stinson, Cryptography Theory and Practice, CRC Press,2018.

**CO-PO Mapping**

| CO | POs |     |     |     |     |     |
|----|-----|-----|-----|-----|-----|-----|
|    | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1  | -   | -   | 1   | 2   | -   | 3   |

|            |   |   |   |   |   |   |
|------------|---|---|---|---|---|---|
| 2          | 1 | - | 2 | 1 | - | 2 |
| 3          | 2 | - | 1 | 2 | 1 | 3 |
| 4          | - | - | 1 | 2 | 1 | 2 |
| 5          | 1 | - | 1 | 2 | 3 | 3 |
| <b>Avg</b> | 1 | - | 1 | 2 | 1 | 3 |

VL4072

CAD FOR VLSI DESIGN

L T P C  
3 0 0 3

**COURSE OBJECTIVES:**

- to introduce the VLSI design methodologies and design methods.
- to introduce data structures and algorithms required for VLSI design.
- to study algorithms for partitioning and placement.
- to study algorithms for floor planning and routing.
- to study algorithms for modelling, simulation and synthesis.

**UNIT I INTRODUCTION**

9

Introduction to VLSI Design Methodologies – VLSI Design Cycle – New Trends in VLSI Design Cycle – Physical Design Cycle – New Trends in Physical Design Cycle – Design Styles – Review of VLSI Design Automation Tools

**UNIT II DATA STRUCTURES AND BASIC ALGORITHMS**

9

Introduction to Data Structures and Algorithms – Algorithmic Graph Theory and Computational Complexity – Tractable and Intractable Problems – General Purpose Methods for Combinatorial Optimization.

**UNIT III ALGORITHMS FOR PARTITIONING AND PLACEMENT**

9

Layout Compaction – Problem Formulation – Algorithms for Constraint Graph Compaction – Partitioning – Placement – Placement Algorithms.

**UNIT IV ALGORITHMS FOR FLOORPLANNING AND ROUTING**

9

Floorplanning – Problem Formulation – Floorplanning Algorithms – Routing – Area Routing – Global Routing – Detailed Routing.

**UNIT V MODELLING, SIMULATION AND SYNTHESIS**

9

Simulation – Gate Level Modeling and Simulation – Logic Synthesis and Verification – Binary Decision Diagrams – High Level Synthesis.

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

At the end of this course, the students should be able to:

**CO1:** use various VLSI design methodologies

**CO2:** understand different data structures and algorithms required for VLSI design.

**CO3:** develop algorithms for partitioning and placement.

**CO4:** develop algorithms for floorplanning and routing.

**CO5:** design algorithms for modelling, simulation and synthesis.

**REFERENCES**

1. Sabih H. Gerez, "Algorithms for VLSI Design Automation", Second Edition, Wiley-India, 2017.
2. Naveed a. Sherwani, "Algorithms for VLSI Physical Design Automation", 3<sup>rd</sup> Edition, Springer, 2017.
3. Charles J. Alpert, Dinesh P. Mehta and Sachin S Sapatnekar, "Handbook of Algorithms for Physical Design Automation, CRC Press, 1<sup>st</sup> Edition, 2.
4. N.a. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers, 2002.

**CO-PO Mapping**

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1          | -   | -   | 2   | -   | -   | -   |
| 2          | -   | -   | 2   | 2   | -   | -   |
| 3          | -   | -   | 2   | -   | -   | 1   |
| 4          | -   | -   | 2   | -   | -   | 1   |
| 5          | -   | -   | 2   | -   | -   | 1   |
| <b>Avg</b> | -   | -   | 2   | 2   | -   | 1   |

**AP4073****SENSORS AND ACTUATORS****L T P C****3 0 0 3****COURSE OBJECTIVES:**

- Understand static and dynamic characteristics of measurement systems.
- Study various types of sensors.
- Study different types of actuators and their usage.
- Study State-of-the-art digital and semiconductor sensors.

**UNIT I INTRODUCTION TO MEASUREMENT SYSTEMS****9**

Introduction to measurement systems: general concepts and terminology, measurement systems, sensor classification, general input-output configuration, methods of correction, performance characteristics: static and dynamic characteristics of measurement systems, zero-order, first-order, and second-order measurement systems and response.

**UNIT II RESISTIVE AND REACTIVE SENSORS 9**

Resistive sensors: potentiometers, strain gages, resistive temperature detectors, magneto resistors, light-dependent resistors, Signal conditioning for resistive sensors: Wheatstone bridge, sensor bridge calibration and compensation, Instrumentation amplifiers, sources of interference and interference reduction, Reactance variation and electromagnetic sensors, capacitive sensors, differential, inductive sensors, linear variable differential transformers (LVDT), magneto elastic sensors, hall effect sensors, Signal conditioning for reactance-based sensors & application to LVDT.

**UNIT III SELF-GENERATING SENSORS 9**

Self-generating sensors: thermoelectric sensors, piezoelectric sensors, pyroelectric sensors, photovoltaic sensors, electrochemical sensors, Signal conditioning for self-generating sensors: chopper and low-drift amplifiers, offset and drifts amplifiers, electrometer amplifiers, charge amplifiers, noise in amplifiers.

**UNIT IV ACTUATORS DRIVE CHARACTERISTICS AND APPLICATIONS 9**

Relays, Solenoid drive, Stepper Motors, Voice-Coil actuators, Servo Motors, DC motors and motor control, 4-to-20 mA Drive, Hydraulic actuators, variable transformers: synchros, resolvers, Inductosyn, resolver-to-digital and digital-to-resolver converters.

**UNIT V DIGITAL SENSORS AND SEMICONDUCTOR DEVICE SENSORS 9**

Digital sensors: position encoders, variable frequency sensors – quartz digital thermometer, vibrating wire strain gages, vibrating cylinder sensors, Sensors based on semiconductor junctions: thermometers based on semiconductor junctions, magneto diodes and magneto transistors, MOSFET transistors, CCD imaging sensors , ultrasonic sensors, fiber-optic sensors.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course the student will be able to :

**CO1:** Compare Actuators with various drive characteristics.

**CO2:** Evaluate digital sensors and semiconductor device sensors performance metrics.

**CO3:** Characterize the performance of Self-generating sensors.

**CO4:** Analyze the performance of self-generating Sensors.

**CO5:** Analyze the performance of resistive and reactive sensors.

**REFERENCES:**

1. Andrzej M. Pawlak Sensors and Actuators in Mechatronics Design and Applications, 2006.
2. D. Johnson, "Process Control Instrumentation Technology", 8th Ed, 2014, John Wiley and Sons.
3. D.Patranabis, "Sensors and Transducers", TMH 2003.
4. E.O. Doebelin, "Measurement System: Applications and Design", McGraw Hill publications,1996
5. Graham Brooker, Introduction to Sensors for ranging and imaging, Yesdee, 2009.
6. Herman K.P. Neubrat, "Instrument Transducers – An Introduction to Their Performance and Design", Oxford University Press. 22,1999.
7. Ian Sinclair, Sensors and Transducers, Elsevier, 3rd Edition, 2011.
8. Jon Wilson , "Sensor Technology Handbook", Newne 2004.
9. Kevin James, PC Interfacing and Data acquisition, Elsevier, 2011.

10. Ramon PallásAreny, John G. Webster, "Sensors and Signal conditioning", 2nd edition, John Wiley and Sons, 2000.
11. Sensors and Actuators: Control System Instrumentation, Clarence W. de Silva CRC Press, 2007

### CO-PO Mapping

| CO  | POs |     |     |     |     |     |
|-----|-----|-----|-----|-----|-----|-----|
|     | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1   | -   | -   | 1   | 2   | -   | 3   |
| 2   | 1   | -   | 2   | 1   | -   | 2   |
| 3   | 2   | -   | 1   | 2   | 1   | 3   |
| 4   | -   | -   | 1   | 2   | 1   | 2   |
| 5   | 1   | -   | 1   | 2   | 3   | 3   |
| Avg | 1   | -   | 1   | 2   | 1   | 3   |

AP4095

**SIGNAL INTEGRITY FOR HIGH SPEED DESIGN**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To identify sources affecting the speed of digital circuits.
- To introduce methods to improve the signal transmission characteristics

**UNIT I SIGNAL PROPAGATION ON TRANSMISSION LINES 9**

Transmission line equations, wave solution, wave vs. circuits, initial wave, delay time, Characteristic impedance , wave propagation, reflection, and bounce diagrams Reactive terminations – L, C , static field maps of micro strip and strip line cross-sections, per unit length parameters, PCB layer stackups and layer/Cu thicknesses, cross-sectional analysis tools, Zo and Td equations for microstrip and stripline Reflection and terminations for logic gates, fan-out, logic switching , input impedance into a transmission-line section, reflection coefficient, skin-effect, dispersion.

**UNIT II MULTI-CONDUCTOR TRANSMISSION LINES AND CROSS-TALK 9**

Multi-conductor transmission-lines, coupling physics, per unit length parameters ,Near and far-end cross-talk, minimizing cross-talk (stripline and microstrip) Differential signalling, termination, balanced circuits ,S-parameters, Lossy and Lossless models.

**UNIT III NON-IDEAL EFFECTS 9**

Non-ideal signal return paths – gaps, BGA fields, via transitions , Parasitic inductance and capacitance , Transmission line losses – Rs, tanδ , routing parasitic, Common-mode current, differential-mode current , Connectors.

**UNIT IV POWER CONSIDERATIONS AND SYSTEM DESIGN 9**

SSN/SSO , DC power bus design , layer stack up, SMT decoupling ,, Logic families, power consumption, and system power delivery , Logic families and speed Package types and parasitic

,SPICE, IBIS models ,Bit streams, PRBS and filtering functions of link-path components , Eye diagrams , jitter , inter-symbol interference Bit-error rate ,Timing analysis.

**UNIT V CLOCK DISTRIBUTION AND CLOCK OSCILLATORS**

**9**

Timing margin, Clock slew, low impedance drivers, terminations, Delay Adjustments, canceling parasitic capacitance, Clock jitter.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course the student will be able to

**CO1:** identify sources affecting the speed of digital circuits.

**CO2:** identify methods to improve the signal transmission characteristics

**CO3:** characterise and model multiconductor transmission line

**CO4:** analyse clock distribution system and understand its design parameters

**CO5:** analyse nonideal effects of transmission line

**REFERENCES**

1. H. W. Johnson and M. Graham, High-Speed Digital Design: A Handbook of Black Magic, Prentice Hall, 1993.
2. Douglas Brooks, Signal Integrity Issues and Printed Circuit Board Design, Prentice Hall PTR , 2003.
3. S. Hall, G. Hall, and J. McCall, High-Speed Digital System Design: A Handboo of Interconnect Theory and Design Practices, Wiley-Interscience, 2000.
4. Eric Bogatin , Signal Integrity – Simplified , Prentice Hall PTR, 2003.

**TOOLS REQUIRED**

1. SPICE, source - <http://www-cad.eecs.berkeley.edu/Software/software.html>
2. HSPICE from synopsis, [www.synopsys.com/products/mixedsignal/hspice/hspice.html](http://www.synopsys.com/products/mixedsignal/hspice/hspice.html)
3. SPECTRAQUEST from Cadence, <http://www.specctraquest.com> or any equivalent open source tool

**CO-PO Mapping**

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1          | -   | -   | 3   | -   | -   | -   |
| 2          | -   | -   | 3   | -   | -   | -   |
| 3          | -   | -   | 2   | 1   | -   | -   |
| 4          | -   | -   | -   | 2   | 2   | -   |
| 5          | -   | -   | 2   | 1   | -   | -   |
| <b>Avg</b> | -   | -   | 3   | 1   | 2   | -   |

**COURSE OBJECTIVES:**

- To acquaint the students with the construction, theory and operation of the basic electronic devices such as PN junction diode, Bipolar and Field Effect Transistors, Power control devices etc.,
- To know about the working principle of LED, LCD and other Opto-electronic devices.
- To introduce the concept of Sensors and voice controls.
- To provide the knowledge on Smart home devices.
- To gain knowledge on current communication technology.

**UNIT I CONSUMER ELECTRONICS FUNDAMENTALS 9**

History of Electronic Devices- Vacuum Tubes, Transistors, Integrated Circuits- Moore Law, Semiconductor Devices, Diodes, Rectifiers, Transistors, Logic Gates, Combinational Circuits, ADC, DAC and Microprocessors, Microprocessor Vs Microcontrollers, Microcontrollers in consumer electronics, Energy management, Intelligent Building Perspective.

**UNIT II ENTERTAINMENT ELECTRONICS 9**

Audio systems: Construction and working principle of: Microphone, Loud speaker, AM and FM receiver, stereo, Home theatre. Display systems: CRT, LCD, LED and Graphics displays Video Players: DVD and Blue RAY. Recording Systems: Digital Cameras and Camcorders.

**UNIT III SMART HOME - SENSORS 9**

Technology involved in Smart home, Home Virtual Assistants- Alexa and Google Home. Home Security Systems - Intruder Detection, Automated blinds, Motion Sensors, Thermal Sensors and Image Sensors, PIR, IR and Water Level Sensors.

**UNIT IV HOME APPLIANCES 9**

Home Enablement Systems: RFID Home, Lighting control, Automatic Cleaning Robots, Washing Machines, Kitchen Electronics- Microwave, Dishwasher, Induction Stoves, Smart Refrigerators, Smart alarms, Smart toilet, Smart floor, Smart locks.

**UNIT V INTRODUCTION TO SMART OS AND COMMUNICATION 9**

Introduction to Smart OS- Android and iOS. Video Conferencing Systems- Web/IP Camera, Video security, Internet Enabled Systems, Wi-Fi, IoT, Li-Fi, GPS and Tracking Systems. Cordless Telephones, Fax Machines, PDAs- Tablets, Smart Phones and Smart Watches.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

Upon successful completion of this course students will be able to

- CO1:** Explain the V-I characteristic of diode, UJT and SCR. Describe the equivalence circuits of transistors.
- CO2:** Operate the basic electronic devices such as PN junction diode, Bipolar and Field Effect Transistors, Power control devices, LED, LCD and other Opto-electronic devices.
- CO3:** Gain knowledge on sensors and controls.
- CO4:** Emphasize the need for communication systems.
- CO5:** Explore the current technology and apply on home applications.

**REFERENCES:**

1. Thomas L Floyd "Electronic Devices" 10th Edition Pearson Education Asia 2018.
2. Jordan Frith, " Smartphones as Locative Media ", Wiley. 2014.
3. Dennis C Brewer, " Home Automation", Que Publishing 2013.
4. Thomas M. Coughlin, "Digital Storage in Consumer Electronics", Elsevier and Newness 2012.
5. Nick vandome, Smart homes in easy steps, - Master smart technology for your home 2018.

**CO-PO Mapping**

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1          | -   | -   | 2   | -   | -   | -   |
| 2          | -   | -   | 2   | 1   | -   | -   |
| 3          | -   | -   | 2   | -   | -   | -   |
| 4          | -   | -   | -   | 1   | 2   | -   |
| 5          | -   | -   | -   | -   | 2   | 2   |
| <b>Avg</b> | -   | -   | 2   | 1   | 2   | 2   |

**AP4008      ADVANCED MICROPROCESSORS AND MICROCONTROLLERS      L T P C**  
**ARCHITECTURES      3 0 0 3**

**COURSE OBJECTIVES:**

- To expose the students to the fundamentals of microprocessor architecture.
- To explore the high performance features in CISC architecture
- To familiarize the high performance features in RISC architecture
- To introduce the basic features in Motorola microcontrollers.
- To enable the students to understand PIC Microcontroller

**UNIT I      MICROPROCESSOR ARCHITECTURE      9**

Instruction Set – Data formats –Addressing modes – Memory hierarchy –register file – Cache – Virtual memory and paging – Segmentation- pipelining –the instruction pipeline – pipeline hazards – instruction level parallelism – reduced instruction set –Computer principles – RISC versus CISC.

**UNIT II      HIGH PERFORMANCE CISC ARCHITECTURE – PENTIUM      9**

CPU Architecture- Bus Operations – Pipelining – Branch predication – floating point unit- Operating Modes –Paging – Multitasking – Exception and Interrupts – Instruction set – addressing modes – Programming the Pentium processor.

**UNIT III      HIGH PERFORMANCE RISC ARCHITECTURE – ARM      9**

Organization of CPU – Bus architecture –Memory management unit - ARM instruction set- Thumb Instruction set- addressing modes – Programming the ARM processor.

**UNIT IV MSP430 16 - BIT MICROCONTROLLER****9**

The MSP430 Architecture- CPU Registers - Instruction Set, On-Chip Peripherals - MSP430 - Development Tools, ADC - PWM - UART - Timer Interrupts - System design using MSP430Microcontroller.

**UNIT V PIC MICROCONTROLLER****9**

CPU Architecture – Instruction set – interrupts- Timers- I2C Interfacing –UART- A/D Converter – PWM and introduction to C-Compilers.

**TOTAL:45 PERIODS****COURSE OUTCOMES:**

At the end of the course the student will be able to

**CO1:** To understand the fundamentals of microprocessor architecture.

**CO2:** To know and appreciate the high performance features in CISC architecture.

**CO3:** To know and appreciate the high performance features in RISC architecture.

**CO4:** To perceive the basic features in Motorola microcontrollers.

**CO5:** To interpret and understand PIC Microcontroller.

**REFERENCES:**

1. Daniel Tabak , „ Advanced Microprocessors” McGraw Hill.Inc., 1995
2. James L. Antonakos , “ The Pentium Microprocessor”, Pearson Education , 1997.
3. Steve Furber , “ ARM System –On –Chip architecture”, Addison Wesley , 2000.
4. Gene .H.Miller .” Micro Computer Engineering ”, Pearson Education , 2003.
5. John .B.Peatman , “ Design with PIC Microcontroller” , Prentice hall, 1997.
6. John H.Davis , “MSP 430 Micro controller basics”, Elsevier, 2008.
7. James L.Antonakos, “An Introduction to the Intel family of Microprocessors”, Pearson Education 1999.
8. Barry.B.Breg, “The Intel Microprocessors Architecture , Programming and Interfacing “, PHI,2002.
9. Valvano "Embedded Microcomputer Systems" Thomson Asia PVT LTD first reprint 2001.
10. Readings: Web links -- [www.ocw.mit.edu](http://www.ocw.mit.edu), [www.arm.com](http://www.arm.com)

**CO-PO Mapping**

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| <b>1</b>   | -   | 1   | 3   | -   | -   | -   |
| <b>2</b>   | -   | -   | 2   | -   | -   | -   |
| <b>3</b>   | -   | -   | 2   | 1   | -   | -   |
| <b>4</b>   | -   | -   | 3   | -   | -   | -   |
| <b>5</b>   | -   | -   | 2   | 1   | -   | -   |
| <b>Avg</b> | -   | 1   | 2   | 1   | -   | -   |

**COURSE OBJECTIVES:**

- Describe the properties and suitable models of biomedical signals
- Introduce the basic signal processing techniques in analyzing biomedical signals
- Develop computational skills in filtering of biomedical signals
- Develop an understanding on ECG signal compression algorithms
- Develop an understanding on feature extraction of biomedical signals

**UNIT I INTRODUCTION TO BIOMEDICAL SIGNALS****9**

Introduction to Biomedical Signals: The nature of Biomedical Signals, Examples of Biomedical Signals, Objectives and difficulties in Biomedical analysis. Electrocardiography: Basic electrocardiography, ECG lead systems, ECG signal characteristics. Signal Conversion :Simple signal conversion systems, Conversion requirements for biomedical signals, Signal conversion circuits

**UNIT II SIGNAL AVERAGING****9**

Signal Averaging: Basics of signal averaging, signal averaging as a digital filter, a typical averager, software for signal averaging, limitations of signal averaging. Adaptive Noise Cancelling: Principal noise canceller model, 60-Hz adaptive cancelling using a sine wave model, other applications of adaptive filtering

**UNIT III DATA COMPRESSION TECHNIQUES****9**

Data Compression Techniques: Turning point algorithm, AZTEC algorithm, Fan algorithm, Huffman coding, data reduction algorithms The Fourier transform, Correlation, Convolution, Power spectrum estimation, Frequency domain analysis of the ECG

**UNIT IV CARDIOLOGICAL SIGNAL PROCESSING****9**

Cardiological signal processing: Basic Electrocardiography, ECG data acquisition, ECG lead system, ECG signal characteristics (parameters and their estimation), Analog filters, ECG amplifier, and QRS detector, Power spectrum of the ECG, Bandpass filtering techniques, Differentiation techniques, Template matching techniques, A QRS detection algorithm, Realtime ECG processing algorithm, ECG interpretation, ST segment analyzer, Portable arrhythmia monitor

**UNIT V NEUROLOGICAL SIGNAL PROCESSING****9**

Neurological signal processing: The brain and its potentials, The electrophysiological origin of brain waves, The EEG signal and its characteristics (EEG rhythms, waves, and transients), Correlation. Analysis of EEG channels: Detection of EEG rhythms, Template matching for EEG, spike and wave detection

**TOTAL : 45 PERIODS****COURSE OUTCOMES:**

At the end of this course the student will be able to

**CO1:** Possess skills necessary to analyze ECG and EEG Signals

- CO2:** Apply classical and modern filtering techniques for ECG and EEG Signals  
**CO3:** Apply classical and modern compression techniques for ECG and EEG Signals  
**CO4:** Develop an understanding on ECG feature extraction  
**CO5:** Develop an understanding on EEG feature extraction

**REFERENCES**

1. Rangaraj M Rangayyan “Biomedical Signal Analysis – A case study approach” IEEE press series in biomedical engineering, First Edition, 2002
2. John G Proakis, Dimitris and G. Manolakis, “Digital Signal Processing Principles algorithms, applications” PHI Third Edition. 2006
3. Willis J. Tompkins “ Biomedical Digital Signal Processing”, EEE, PHI, 2004
4. D C Reddy “Biomedical Signal Processing: Principles and Techniques”, Tata McGraw-Hill Publishing Co. Ltd, 2005
5. J G Webster “Medical Instrumentation: Application & Design”, John Wiley & Sons Inc., 2001

**CO-PO Mapping**

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1          | -   | -   | 1   | 2   | -   | 3   |
| 2          | 1   | -   | 2   | 1   | -   | 2   |
| 3          | 2   | -   | 1   | 2   | 1   | 3   |
| 4          | -   | -   | 1   | 2   | 1   | 2   |
| 5          | 1   | -   | 1   | 2   | 3   | 3   |
| <b>Avg</b> | 1   | -   | 1   | 2   | 1   | 3   |

**AP4010**

**MODELING AND SYNTHESIS WITH HDL**

**L T P C**  
**3 0 2 4**

**COURSE OBJECTIVES:**

- To know the basic language features of Verilog HDL and its the role in digital logic design.
- To know the behavioural modeling of combinational and sequential circuits.
- To know the behavioural modeling of algorithmic state machines.
- To know the synthesis of combinational and sequential descriptions.
- To know the architectural features of programmable logic devices.

**UNIT I**

**INTRODUCTION TO LOGIC DESIGN WITH VERILOG**

**07**

**Overview of Digital Design with Verilog HDL - Hierarchical Modeling Concepts:** Top-down and bottom-up design methodology, differences between modules and module instances, parts of a simulation, design block, stimulus block - **Basic Concept- Modules and Ports:** Module definition, port declaration, connecting ports, hierarchical name referencing. **Tasks and Functions**



## REFERENCES

1. Samir Palnitkar - Verilog HDL, 2nd edition, Pearson Education, 2003.
2. Michael D Ciletti - Advanced Digital Design with the VERILOG HDL, 2ND Edition, PHI, 2009.
3. Z Navabi - Verilog Digital System Design, 2nd Edition, McGraw Hill, 2005.
4. Stephen Brown and Zvonko Vranesic - Fundamentals of Digital Logic with Verilog, 2nd Edition, TMH, 2008.

### CO-PO Mapping

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1          | 3   | -   | 2   | -   | 2   | -   |
| 2          | 1   | -   | -   | 2   | 3   | -   |
| 3          | 3   | -   | 2   | -   | 3   | -   |
| 4          | -   | -   | 2   | 1   | 3   | 2   |
| 5          | 2   | -   | 1   | 2   | -   | 1   |
| <b>Avg</b> | 2   | -   | 2   | 2   | 3   | 2   |

IF4071

### DEEP LEARNING

**L T P C**  
**3 0 2 4**

#### COURSE OBJECTIVES:

- Develop and Train Deep Neural Networks.
- Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition
- Build and train RNNs, work with NLP and Word Embeddings
- The internal structure of LSTM and GRU and the differences between them
- The Auto Encoders for Image Processing

#### UNIT I DEEP LEARNING CONCEPTS

**6**

Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. Early Neural Networks. How Deep Learning different from Machine Learning. Scalars. Vectors. Matrixes, Higher Dimensional Tensors. Manipulating Tensors. Vector Data. Time Series Data. Image Data. Video Data.

#### UNIT II NEURAL NETWORKS

**9**

About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. Loss Functions. Data Pre-processing for neural networks, Feature Engineering. Overfitting and Underfitting. Hyperparameters.

#### UNIT III CONVOLUTIONAL NEURAL NETWORK

**10**

About CNN. Linear Time Invariant. Image Processing Filtering. Building a convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Backpropagation Through

the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions. Various Optimizers. LeNet, AlexNet, VGG16, ResNet. Transfer Learning with Image Data. Transfer Learning using Inception Oxford VGG Model, Google Inception Model, Microsoft ResNet Model. R-CNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO

**UNIT VI NATURAL LANGUAGE PROCESSING USING RNN 10**

About NLP & its Toolkits. Language Modeling . Vector Space Model (VSM). Continuous Bag of Words (CBOW). Skip-Gram Model for Word Embedding. Part of Speech (PoS) Global Co-occurrence Statistics–based Word Vectors. Transfer Learning. Word2Vec. Global Vectors for Word Representation GloVe. Backpropagation Through Time. Bidirectional RNNs (BRNN) . Long Short Term Memory (LSTM). Bi-directional LSTM. Sequence-to-Sequence Models (Seq2Seq). Gated recurrent unit GRU.

**UNIT V DEEP REINFORCEMENT & UNSUPERVISED LEARNING 10**

About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy Gradient Methods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding. Variational Auto Encoding. Generative Adversarial Networks. Autoencoders for Feature Extraction. Auto Encoders for Classification. Denoising Autoencoders. Sparse Autoencoders

**LIST OF EXPERIMENTS: 30**

- 1: Feature Selection from Video and Image Data
- 2: Image and video recognition
- 3: Image Colorization
- 4: Aspect Oriented Topic Detection & Sentiment Analysis
- 5: Object Detection using Autoencoder

**COURSE OUTCOMES:**

- CO1:** Feature Extraction from Image and Video Data
- CO2:** Implement Image Segmentation and Instance Segmentation in Images
- CO3:** Implement image recognition and image classification using a pretrained network (Transfer Learning)
- CO4:** Traffic Information analysis using Twitter Data
- CO5:** Autoencoder for Classification & Feature Extraction

**TOTAL : 45+30=75 PERIODS**

**REFERENCES**

- 1. Deep Learning A Practitioner’s Approach Josh Patterson and Adam Gibson O’Reilly Media, Inc.2017
- 2. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
- 3. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
- 4. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017
- 5. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017

**CO-PO Mapping**

| CO | POs |     |     |     |     |     |
|----|-----|-----|-----|-----|-----|-----|
|    | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|    |     |     |     |     |     |     |

|            |   |   |   |   |   |   |
|------------|---|---|---|---|---|---|
| <b>1</b>   | 3 | - | - | 2 | - | - |
| <b>2</b>   | - | - | - | 3 | - | - |
| <b>3</b>   | 2 | - | 2 | 3 | - | - |
| <b>4</b>   | 3 | - | 2 | 3 | 2 | - |
| <b>5</b>   | 2 | - | 3 | 2 | 2 | - |
| <b>Avg</b> | 3 | - | 2 | 3 | 2 | - |

**AP4011**

**ADVANCED DIGITAL IMAGE PROCESSING**

**L T P C**  
**3 0 2 4**

**COURSE OBJECTIVES:**

- To understand the image fundamentals and mathematical transforms necessary for image processing and to study the image enhancement techniques.
- To understand the image segmentation and representation techniques.
- To understand how image are analyzed to extract features of interest.
- To introduce the concepts of image registration and image fusion.
- To analyze the constraints in image processing when dealing with 3D data sets.

**UNIT I                      FUNDAMENTALS OF DIGITAL IMAGE PROCESSING                      9**

Elements of visual perception, brightness, contrast, hue, saturation, mach band effect, 2D image transforms-DFT, DCT, KLT, and SVD. Image enhancement in spatial and frequency domain, Morphological image processing.

**UNIT II                      SEGMENTATION                      9**

Edge detection, Thresholding, Region growing, Fuzzy clustering, Watershed algorithm, Active contour methods, Texture feature-based segmentation, Model based segmentation, Atlas based segmentation, Wavelet based Segmentation methods.

**UNIT III                      FEATURE EXTRACTION                      9**

First and second order edge detection operators, Phase congruency, Localized feature extraction- detecting image curvature, shape features Hough transform, shape skeletonization, Boundary descriptors, Moments, Texture descriptors- Autocorrelation, Co-occurrence features, Run length features, Fractal model-based features, Gabor filter, wavelet features.

**UNIT IV                      REGISTRATION AND IMAGE FUSION                      9**

Registration- Pre-processing, Feature selection-points, lines, regions and templates Feature Correspondence-Point pattern matching, Line matching, region matching Template matching. Transformation functions-Similarity transformation and Affine Transformation. Resampling- Nearest Neighbour and Cubic Splines Image Fusion-Overview of image fusion, pixel fusion, Multiresolution based fusion discrete wavelet transforms, Curvelet transform. Region based fusion.

Sources of 3D Data sets, Slicing the Data set, Arbitrary section planes, The use of color, Volumetric display, Stereo Viewing, Ray tracing, Reflection, Surfaces, multiply connected surfaces, Image processing in 3D, Measurements on 3D images.

**PRACTICALS:**

1. Wavelet and DCT based Image Compression
2. Geometrical transformations and Interpolation of Images
3. Edge Detection using Canny edge detector
4. Region based , threshold based and Watershed Segmentation
5. Image filtering using DFT
6. Texture, Gabor and Wavelet Feature Extraction
7. Image fusion using Wavelets
8. Segmenting 3D Image volume using K-means clustering.
9. Segmentation of Lungs from 3D- Chest Scan.

**COURSE OUTCOMES:**

Upon Completion of the course, the students will be able to

**CO1:**To understand image formation and the role of human visual system plays in perception of gray and color image data.

**CO2:**To apply image processing techniques in both the spatial and frequency (Fourier) domains.

**CO3:**To design image analysis techniques in the form of image segmentation and to evaluate the methodologies for segmentation.

**CO4:**To conduct independent study and analysis of feature extraction techniques.

**CO5:**To understand the concepts of image registration and image fusion.

**CO6:**To analyze the constraints in image processing when dealing with 3D data sets and to apply image processing algorithms in practical applications.

**TOTAL: 45+30=75 PERIODS**

**REFERENCES**

1. John C.Russ, "The Image Processing Handbook", CRC Press, 2007.
2. Mark Nixon, Alberto Aguado, "Feature Extraction and Image Processing", Academic Press, 2008.
3. Ardeshir Goshtasby, "2D and 3D Image registration for Medical, Remote Sensing and Industrial Applications", John Wiley and Sons, 2005.
4. Rafael C. Gonzalez, Richard E. Woods, , Digital Image Processing', Pearson, Education, Inc., Second Edition, 2004.
5. Anil K. Jain, , Fundamentals of Digital Image Processing', Pearson Education, Inc., 2002.
6. Rick S.Blum, Zheng Liu," Multisensor image fusion and its Applications", Taylor & Francis, 2006.

### CO-PO Mapping

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1          | -   | -   | 1   | 3   | -   | -   |
| 2          | 1   | -   | 2   | 2   | 1   | -   |
| 3          | 2   | -   | 2   | 3   | 2   | 1   |
| 4          | -   | -   | 1   | 3   | -   | -   |
| 5          | 2   | -   | 2   | 3   | 3   | 1   |
| <b>Avg</b> | 2   | -   | 2   | 3   | 2   | 1   |

AP4072

PCB DESIGN

L T P C  
3 0 2 4

#### COURSE OBJECTIVES:

- Understand the need for PCB Design and steps involved in PCB Design and Fabrication process.
- Familiarize Schematic and layout design flow using Electronic Design Automation (EDA) Tools.
- Understand basic concepts of transmission line, crosstalk and thermal issues
- Design (schematic and layout) PCB for analog circuits, digital circuits and mixed circuits.
- Schematic creation & interpretation

#### UNIT I INTRODUCTION TO PRINTED CIRCUIT BOARD

9

**Introduction to Printed circuit board:** fundamental of electronic components, basic electronic circuits, Basics of printed circuit board designing: Layout planning, general rules and parameters, ground conductor considerations, thermal issues, check and inspection of artwork.

#### UNIT II DESIGN RULES FOR PCB

9

**Design rules for PCB:** Design rules for Digital circuit PCBs, Analog circuit PCBs, high frequency and fast pulse applications, Power electronic applications, Microwave applications,  
**PCB Technology Trends:** Multilayer PCBs. Multiwire PCB, Flexible PCBs, Surface mount PCBs, Reflow soldering, Introduction to High-Density Interconnection (HDI) Technology.

#### UNIT III INTRODUCTION TO ELECTRONIC DESIGN AUTOMATION(EDA) TOOLS FOR PCB DESIGNING

9

**Introduction to Electronic design automation(EDA) tools for PCB designing:** Brief Introduction of various simulators, SPICE and PSpice Environment, Selecting the Components Footprints as per design, Making New Footprints, Assigning Footprint to components, Net listing, PCB Layout Designing, Auto routing and manual routing. Assigning specific text (silkscreen) to design, Creating report of design, creating manufacturing data (GERBER) for design.

## UNIT IV INTRODUCTION PRINTED CIRCUIT BOARD PRODUCTION TECHNIQUES

9

**Introduction printed circuit board production techniques:** Photo printing, film-master production, reprographic camera, basic process for double sided PCBs photo resists, Screen printing process, plating, relative performance and quality control, Etching machines, Solders alloys, fluxes, soldering techniques, Mechanical operations

## UNIT V PCB DESIGN FOR EMI/EMC

9

**PCB design for EMI/EMC:** Subsystem/PCB Placement in an enclosure, Filtering circuit placement, decoupling and bypassing, Electronic discharge protection, Electronic waste; Printed circuit boards Recycling techniques, Introduction to Integrated Circuit Packaging and footprints, NEMA and IPC standards.

### SUGGESTED ACTIVITIES:

1. Using any Electronic design automation (EDA) software, Practice following PCB Design steps (Open source EDA Tool KiCad Preferable or equivalent ) Example circuit: Basic RC Circuit Schematic Design: Familiarization of the Schematic Editor, Schematic creation, Annotation, Netlist generation Layout Design: Familiarization of Footprint Editor, Mapping of components, Creation of PCB layout Schematic Create new schematic components Create new component footprints.
2. Fabricate single-sided PCB, mount the components and assemble in a cabinet for any one of the circuits mentioned below.
3. Regulator circuit using 7805.
4. Astable or Monostable multivibrator using IC555
5. RC Phase-shift or Wein-bridge Oscillator using transistor.
6. 4 bit binary /MOD N counter using D-Flip flops.
7. Design a 8051 Development board having Power section consisting of IC7805, capacitor, resistor, headers, LED, Serial communication section consisting of MAX 232, Capacitors, DB9 connector, Jumper, LEDs, Reset & Input/ output sections consisting of 89C51 Microcontroller, Electrolytic Capacitor, Resistor, Jumper, Crystal Oscillator, Capacitors.
8. Touch plate switches – transistorized or 555 based
9. Doorbell/cordless bell
10. Clapping switch and IR switch
11. Blinkers
12. Cell charger, battery charger, mobile charger
13. Fire/smoke/intruder alarm
14. Liquid level controller
15. Audio amplifiers

### COURSE OUTCOMES:

Upon the completion of this course, students will demonstrate the ability to:

**CO1:** Appreciate the necessity and evolution of PCB, types and classes of PCB.

**CO2:** Understand the steps involved in schematic, layout, fabrication and assembly process of PCB design.

**CO3:** Apply advanced techniques, skills and modern tools for designing and fabrication of PCBs.

**CO4:** Apply the knowledge and techniques to fabricate Multilayer, SMT and HDI PCB.

**CO5:** Design (schematic and layout) and fabricate PCB for simple circuits.

**REFERENCES**

1. Printed circuit board design ,fabrication assembly and testing By R. S. Khandpur, Tata McGraw Hill 2006
2. Printed Circuits Handbook, Sixth Edition,by Clyde F. Coombs, Jr, Happy T. Holden,Publisher: McGraw-Hill Education Year: 2016
3. Complete PCB Design Using OrCAD Capture and PCB Editor,Kraig Mitzner Bob Doe Alexander Akulin Anton Suponin Dirk Müller, 2nd Edition 2009.
4. Introduction to System-on-Package, Rao R ,Tummala,&MadhavanSwaminathan, McGraw Hill, 2008
5. EMC and Printed circuit board ,Design theory and layout, Mark I Montrose IEEE compatibility society
6. Electronic Product Design Volume-I by S D Mehta, S Chand Publications
7. Open source EDA Tool KiCad Tutorial: <http://kicad-pcb.org/help/tutorials/>
8. PCB Fabrication user guide page: <http://www.wikihow.com/Create-Printed-Circuit-Boards> , [http://www.siongboon.com/projects/2005-09-07\\_home\\_pcb\\_fabrication/](http://www.siongboon.com/projects/2005-09-07_home_pcb_fabrication/) ,
9. [http://reprap.org/wiki/MakePCBInstructions#Making\\_PCBs\\_yourself](http://reprap.org/wiki/MakePCBInstructions#Making_PCBs_yourself)
10. PCB Fabrication at home(video): <https://www.youtube.com/watch?v=mv7Y0A9YeUc>,
11. <https://www.youtube.com/watch?v=imQTCW1yWkg>

**CO-PO Mapping**

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1          | -   | -   | -   | -   | 2   | -   |
| 2          | -   | -   | -   | 2   | -   | -   |
| 3          | 2   | -   | -   | 3   | 3   | 1   |
| 4          | -   | -   | -   | 3   | 2   | -   |
| 5          | -   | -   | -   | -   | 2   | 1   |
| <b>Avg</b> | 2   | -   | -   | 3   | 2   | 1   |

**AUDIT COURSES**

**AX4091**

**ENGLISH FOR RESEARCH PAPER WRITING**

**L T P C  
2 0 0 0**

**COURSE OBJECTIVES:**

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion

- Ensure the quality of paper at very first-time submission

**UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6**  
 Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

**UNIT II PRESENTATION SKILLS 6**  
 Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

**UNIT III TITLE WRITING SKILLS 6**  
 Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

**UNIT IV RESULT WRITING SKILLS 6**  
 Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

**UNIT V VERIFICATION SKILLS 6**  
 Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

**TOTAL: 30 PERIODS**

**COURSE OUTCOMES:**

- CO1 –Understand that how to improve your writing skills and level of readability
- CO2 – Learn about what to write in each section
- CO3 – Understand the skills needed when writing a Title
- CO4 – Understand the skills needed when writing the Conclusion
- CO5 – Ensure the good quality of paper at very first-time submission

**REFERENCES:**

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

**CO-PO Mapping**

| CO | POs |     |     |     |     |     |
|----|-----|-----|-----|-----|-----|-----|
|    | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1  | -   | 3   | -   | -   | -   | -   |
| 2  | -   | 3   | -   | -   | -   | -   |
| 3  | -   | 3   | -   | -   | -   | -   |
| 4  | -   | 3   | -   | -   | -   | -   |

|            |   |   |   |   |   |   |
|------------|---|---|---|---|---|---|
| <b>5</b>   | - | 3 | - | - | - | - |
| <b>Avg</b> | - | 3 | - | - | - | - |

**AX4092**

**DISASTER MANAGEMENT**

**L T P C**  
**2 0 0 0**

**COURSE OBJECTIVES:**

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

**UNIT I INTRODUCTION 6**

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

**UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6**

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

**UNIT III DISASTER PRONE AREAS IN INDIA 6**

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

**UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6**

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

**UNIT V RISK ASSESSMENT 6**

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

**TOTAL : 30 PERIODS**

**COURSE OUTCOMES:**

CO1: Ability to summarize basics of disaster

CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5: Ability to develop the strengths and weaknesses of disaster management approaches

**REFERENCES:**

1. Goel S. L., Disaster Administration And Management Text And Case Studies”,Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, “Disaster Management in India: Perspectives, issues and strategies “NewRoyal book Company,2007.
3. Sahni, PardeepEt.Al. ,” Disaster Mitigation Experiences And Reflections”, Prentice Hall OfIndia, New Delhi,2001.

**CO-PO Mapping**

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1          | -   | -   | -   | 1   | -   | 1   |
| 2          | -   | -   | 1   | 2   | -   | 1   |
| 3          | -   | -   | 1   | 2   | 1   | -   |
| 4          | -   | -   | 1   | 2   | 2   | -   |
| 5          | -   | -   | 1   | 2   | -   | -   |
| <b>Avg</b> | -   | -   | 1   | 2   | 1   | 1   |

**AX4093**

**CONSTITUTION OF INDIA**

**L T P C  
2 0 0 0**

**COURSE OBJECTIVES:**

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals’ constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

**UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION**

History, Drafting Committee, (Composition & Working)

**UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION**

Preamble, Salient Features

**UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES**

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

#### UNIT IV ORGANS OF GOVERNANCE

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

#### UNIT V LOCAL ADMINISTRATION

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

#### UNIT VI ELECTION COMMISSION

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

**TOTAL: 30 PERIODS**

#### COURSE OUTCOMES:

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

#### SUGGESTED READING

1. The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1<sup>st</sup> Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7<sup>th</sup> Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

#### CO-PO Mapping

| CO         | POs |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|
|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1          | -   | -   | 2   | -   | 1   | -   |
| 2          | 1   | -   | -   | -   | 2   | -   |
| 3          | -   | -   | -   | 2   | -   | 2   |
| 4          | -   | -   | 3   | 1   | -   | -   |
| 5          | -   | 2   | -   | -   | 2   | -   |
| <b>Avg</b> | 1   | 2   | 3   | 2   | 2   | 2   |

|                 |  |          |
|-----------------|--|----------|
| <b>UNIT I</b>   | <b>சங்க இலக்கியம்</b>  | <b>6</b> |
|                 | <ol style="list-style-type: none"> <li>1. தமிழின் துவக்க நூல் தொல்காப்பியம்<br/>- எழுத்து, சொல், பொருள்</li> <li>2. அகநானூறு (82)<br/>- இயற்கை இன்னிசை அரங்கம்</li> <li>3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி</li> <li>4. புறநானூறு (95,195)<br/>- போரை நிறுத்திய ஔவையார்</li> </ol>   |          |
| <b>UNIT II</b>  | <b>அறநெறித் தமிழ்</b>  | <b>6</b> |
|                 | <ol style="list-style-type: none"> <li>1. அறநெறி வகுத்த திருவள்ளுவர்<br/>- அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புறவு அறிதல், ஈகை, புகழ்</li> <li>2. பிற அறநூல்கள் - இலக்கிய மருந்து<br/>- ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல்)</li> </ol>   |          |
| <b>UNIT III</b> | <b>இரட்டைக் காப்பியங்கள்</b>   | <b>6</b> |
|                 | <ol style="list-style-type: none"> <li>1. கண்ணகியின் புரட்சி<br/>- சிலப்பதிகார வழக்குரை காதை</li> <li>2. சமூகசேவை இலக்கியம் மணிமேகலை<br/>- சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை</li> </ol>  |          |
| <b>UNIT IV</b>  | <b>அருள்நெறித் தமிழ்</b>   | <b>6</b> |
|                 | <ol style="list-style-type: none"> <li>1. சிறுபாணாற்றுப்படை<br/>- பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்</li> <li>2. நற்றிணை<br/>- அன்னைக்குரிய புன்னை சிறப்பு</li> <li>3. திருமந்திரம் (617, 618)<br/>- இயமம் நியமம் விதிகள்</li> <li>4. தர்மச்சாலையை நிறுவிய வள்ளலார்</li> <li>5. புறநானூறு<br/>- சிறுவனே வள்ளலானான்</li> <li>6. அகநானூறு (4) - வண்டு<br/>நற்றிணை (11) - நண்டு<br/>கலித்தொகை (11) - யானை, புறா<br/>ஐந்திணை 50 (27) - மான்</li> </ol> |          |

**UNIT V**

**நவீன தமிழ் இலக்கியம்**

6

1. உரைநடைத் தமிழ்,
  - தமிழின் முதல் புதினம்,
  - தமிழின் முதல் சிறுகதை,
  - கட்டுரை இலக்கியம்,
  - பயண இலக்கியம்,
  - நாடகம்,
2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்,
6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

**TOTAL: 30 PERIODS**

**தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்**

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University)- [www.tamilvu.org](http://www.tamilvu.org)
2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia) -<https://ta.wikipedia.org>
3. தர்மபுர ஆதீன வெளியீடு
4. வாழ்வியல் களஞ்சியம்
  - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம்
  - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம்
  - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்

**OPEN ELECTIVES**

OCE431

**INTEGRATED WATER RESOURCES MANAGEMENT**

**L T P C**

**3 0 0 3**

**OBJECTIVE**

- Students will be introduced to the concepts and principles of IWRM, which is inclusive of the economics, public-private partnership, water & health, water & food security and legal & regulatory settings.

**UNIT I CONTEXT FOR IWRM**

9

Water as a global issue: key challenges – Definition of IWRM within the broader context of development – Key elements of IWRM - Principles – Paradigm shift in water management - Complexity of the IWRM process – UN World Water Assessment - SDGs.

**UNIT II WATER ECONOMICS 9**

Economic view of water issues: economic characteristics of water good and services – Non-market monetary valuation methods – Water economic instruments – Private sector involvement in water resources management: PPP objectives, PPP models, PPP processes, PPP experiences through case studies.

**UNIT III LEGAL AND REGULATORY SETTINGS 9**

Basic notion of law and governance: principles of international and national law in the area of water management - Understanding UN law on non-navigable uses of international water courses – International law for groundwater management – World Water Forums – Global Water Partnerships - Development of IWRM in line with legal and regulatory framework.

**UNIT IV WATER AND HEALTH WITHIN THE IWRM CONTEXT 9**

Links between water and health: options to include water management interventions for health – Health protection and promotion in the context of IWRM – Global burden of Diseases - Health impact assessment of water resources development projects – Case studies.

**UNIT V AGRICULTURE IN THE CONCEPT OF IWRM 9**

Water for food production: ‘blue’ versus ‘green’ water debate – Water foot print - Virtual water trade for achieving global water and food security – Irrigation efficiencies, irrigation methods - current water pricing policy– scope to relook pricing.

**TOTAL: 45 PERIODS**

**OUTCOMES**

- On completion of the course, the student is expected to be able to

|            |   |
|------------|---|
| <b>CO1</b> | Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management.    |
| <b>CO2</b> | Select the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies. |
| <b>CO3</b> | Apply law and governance in the context of IWRM.  |
| <b>CO4</b> | Discuss the linkages between water-health; develop a HIA framework.   |
| <b>CO5</b> | Analyse how the virtual water concept pave way to alternate policy options.                                       |

**REFERENCES:**

1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
2. Mollinga .P. etal “ Integrated Water Resources Management”, Water in South Asia Volume I, Sage Publications, 2006.
3. Technical Advisory Committee, Integrated Water Resources management, Technical Advisory Committee Background Paper No: 4. Global water partnership, Stockholm, Sweden. 2002.
4. Technical Advisory Committee, Dublin principles for water as reflected in comparative assessment of institutional and legal arrangements for Integrated Water Resources Management, Technical Advisory Committee Background paper No: 3. Global water partnership, Stockholm, Sweden. 1999.
5. Technical Advisory Committee, Effective Water Governance”. Technical Advisory Committee Background paper No: 7. Global water partnership, Stockholm, Sweden, 2003.

**OBJECTIVES:**

- Understand the accelerating health impacts due to the present managerial aspects and initiatives in water and sanitation and health sectors in the developing scenario

**UNIT I FUNDAMENTALS WASH****9**

Meanings and Definition: Safe Water- Health, Nexus: Water- Sanitation - Health and Hygiene – Equity issues-Water security - Food Security. Sanitation And Hygiene (WASH) and Integrated Water Resources Management (IWRM) - Need and Importance of WASH

**UNIT II MANAGERIAL IMPLICATIONS AND IMPACT****9**

Third World Scenario – Poor and Multidimensional Deprivation--Health Burden in Developing Scenario -Factors contribute to water, sanitation and hygiene related diseases-Social: Social Stratification and Literacy Demography: Population and Migration- Fertility - Mortality- Environment: Water Borne-Water Washed and Water Based Diseases - Economic: Wage - Water and Health Budgeting -Psychological: Non-compliance - Disease Relapse - Political: Political Will.

**UNIT III CHALLENGES IN MANAGEMENT AND DEVELOPMENT****9**

Common Challenges in WASH - Bureaucracy and Users- Water Utilities -Sectoral Allocation:- Infrastructure- Service Delivery: Health services: Macro and Micro- level: Community and Gender Issues- Equity Issues - Paradigm Shift: Democratization of Reforms and Initiatives.

**UNIT IV GOVERNANCE****9**

Public health -Community Health Assessment and Improvement Planning (CHA/CHIP)- Infrastructure and Investments on Water, (WASH) - Cost Benefit Analysis – Institutional Intervention-Public Private Partnership - Policy Directives - Social Insurance -Political Will vs Participatory Governance -

**UNIT V INITIATIVES****9**

Management vs Development -Accelerating Development- Development Indicators -Inclusive Development-Global and Local- Millennium Development Goal (MDG) and Targets - Five Year Plans - Implementation - Capacity Building - Case studies on WASH.

**TOTAL: 45 PERIODS****OUTCOMES:**

|            |  |
|------------|--|
| <b>CO1</b> | Capture to fundamental concepts and terms which are to be applied and understood all through the study.  |
| <b>CO2</b> | Comprehend the various factors affecting water sanitation and health through the lens of third world scenario.   |
| <b>CO3</b> | Critically analyse and articulate the underlying common challenges in water, sanitation and health.  |
| <b>CO4</b> | Acquire knowledge on the attributes of governance and its say on water sanitation and health.  |
| <b>CO5</b> | Gain an overarching insight in to the aspects of sustainable resource management in the absence of a clear level playing field in the developmental aspects. |

**REFERENCES**

1. Bonitha R., Beaglehole R., Kjellstorm, 2006, "Basic Epidemiology", 2<sup>nd</sup> Edition, World Health Organization.

2. Van Note Chism, N. and Bickford, D. J. (2002), Improving the environment for learning: An expanded agenda. *New Directions for Teaching and Learning*, 2002: 91–98. doi: 10.1002/tl.83Improving the Environment for learning: An Expanded Agenda
3. National Research Council. *Global Issues in Water, Sanitation, and Health: Workshop Summary*. Washington, DC: The National Academies Press, 2009.
4. Sen, Amartya 1997. *On Economic Inequality*. Enlarged edition, with annex by James Foster and Amartya Sen, Oxford: Clarendon Press, 1997.
5. *Intersectoral Water Allocation Planning and Management*, 2000, World Bank Publishers www. Amazon.com
6. Third World Network.org (www.twn.org).

**OCE433**

**PRINCIPLES OF SUSTAINABLE DEVELOPMENT**

**L T P C  
3 0 0 3**

**OBJECTIVES:**

- To impart knowledge on environmental, social and economic dimensions of sustainability and the principles evolved through landmark events so as to develop an action mindset for sustainable development.

**UNIT I SUSTAINABILITY AND DEVELOPMENT CHALLENGES 9**

Definition of sustainability – environmental, economical and social dimensions of sustainability - sustainable development models – strong and weak sustainability – defining development-millennium development goals – mindsets for sustainability: earthly, analytical, precautionary, action and collaborative– syndromes of global change: utilisation syndromes, development syndromes, and sink syndromes – core problems and cross cutting Issues of the 21 century - global, regional and local environmental issues – social insecurity - resource degradation –climate change – desertification.

**UNIT II PRINCIPLES AND FRAME WORK 9**

History and emergence of the concept of sustainable development - our common future - Stockholm to Rio plus 20– Rio Principles of sustainable development – Agenda 21 natural step-peoples earth charter – business charter for sustainable development –UN Global Compact - Role of civil society, business and government – United Nations’ 2030 Agenda for sustainable development – 17 sustainable development goals and targets, indicators and intervention areas

**UNIT III SUSTAINABLE DEVELOPMENT AND WELLBEING 9**

The Unjust World and inequities - Quality of Life - Poverty, Population and Pollution - Combating Poverty - - Demographic dynamics of sustainability - Strategies to end Rural and Urban Poverty and Hunger – Sustainable Livelihood Framework- Health, Education and Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities and Industry for Prevention, Precaution , Preservation and Public participation.

**UNIT IV SUSTAINABLE SOCIO-ECONOMIC SYSTEMS 10**

Sustainable Development Goals and Linkage to Sustainable Consumption and Production – Investing in Natural Capital- Agriculture, Forests, Fisheries - Food security and nutrition and sustainable agriculture- Water and sanitation - Biodiversity conservation and Ecosystem integrity –

Ecotourism - Sustainable Cities – Sustainable Habitats- Green Buildings - Sustainable Transportation — Sustainable Mining - Sustainable Energy– Climate Change –Mitigation and Adaptation - Safeguarding Marine Resources - Financial Resources and Mechanisms

**UNIT V ASSESSING PROGRESS AND WAY FORWARD 8**

Nature of sustainable development strategies and current practice- Sustainability in global, regional and national context –Approaches to measuring and analysing sustainability– limitations of GDP- Ecological Footprint- Human Development Index- Human Development Report – National initiatives for Sustainable Development - Hurdles to Sustainability - Science and Technology for sustainable development –Performance indicators of sustainability and Assessment mechanism – Inclusive Green Growth and Green Economy – National Sustainable Development Strategy Planning and National Status of Sustainable Development Goals

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- On completion of the course, the student is expected to be able to

|     |  |
|-----|--|
| CO1 | Explain and evaluate current challenges to sustainability, including modern world social, environmental, and economic structures and crises.   |
| CO2 | Identify and critically analyze the social environmental, and economic dimensions of sustainability in terms of UN Sustainable development goals                                       |
| CO3 | Develop a fair understanding of the social, economic and ecological linkage of Human well being, production and consumption  |
| CO4 | Evaluate sustainability issues and solutions using a holistic approach that focuses on connections between complex human and natural systems.  |
| CO5 | Integrate knowledge from multiple sources and perspectives to understand environmental limits governing human societies and economies and social justice dimensions of sustainability. |

**REFERENCES:**

- Tom Theis and Jonathan Tomkin, Sustainability: A Comprehensive Foundation, Rice University, Houston, Texas, 2012
- A guide to SDG interactions:from science to implementation, International Council for Science, Paris,2017
- Karel Mulder, Sustainable Development for Engineers - A Handbook and Resource Guide, Roulledge Taylor and Francis, 2017.
- The New Global Frontier - Urbanization, Poverty and Environmentin the 21st Century - *George Martine,Gordon McGranahan,Mark Montgomery and Rogelio Fernández-Castilla*, IIED and UNFPA, Earthscan, UK, 2008
- Nolberto Munier, Introduction to Sustainability: Road to a Better Future, Springer, 2006
- Barry Dalal Clayton and Stephen Bass, Sustainable Development Strategies- a resource book”, Earthscan Publications Ltd, London, 2002.

**OCE434 ENVIRONMENTAL IMPACT ASSESSMENT L T P C  
3 0 0 3**

**OBJECTIVES:**

- To make the students to understand environmental clearance, its legal requirements and to provide knowledge on overall methodology of EIA, prediction tools and models, environmental management plan and case studies.

**UNIT I INTRODUCTION 9**

Historical development of Environmental Impact Assessment (EIA). Environmental Clearance- EIA

in project cycle. legal and regulatory aspects in India – types and limitations of EIA –EIA process- screening – scoping - terms of reference in EIA- setting – analysis – mitigation. Cross sectoral issues –public hearing in EIA- EIA consultant accreditation.

**UNIT II      IMPACT IDENTIFICATION AND PREDICTION      10**

Matrices – networks – checklists – cost benefit analysis – analysis of alternatives – expert systems in EIA. prediction tools for EIA – mathematical modeling for impact prediction – assessment of impacts – air – water – soil – noise – biological — cumulative impact assessment

**UNIT III      SOCIO-ECONOMIC IMPACT ASSESSMENT      8**

Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation

**UNIT IV      EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN      9**

Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment

**UNIT V      CASE STUDIES      9**

Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- On completion of the course, the student is expected to be able to

|            |   |
|------------|---|
| <b>CO1</b> | Understand need for environmental clearance, its legal procedure, need of EIA, its types, stakeholders and their roles          |
| <b>CO2</b> | Understand various impact identification methodologies, prediction techniques and model of impacts on various environments      |
| <b>CO3</b> | Understand relationship between social impacts and change in community due to development activities and rehabilitation methods |
| <b>CO4</b> | Document the EIA findings and prepare environmental management and monitoring plan  |
| <b>CO5</b> | Identify, predict and assess impacts of similar projects based on case studies  |

**REFERENCES:**

1. EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India
2. Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India
3. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996
4. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey. 2003
5. Lee N. and George C. 2000. Environmental Assessment in Developing and Transitional

Countries. Chichester: Willey

6. World Bank –Source book on EIA ,1999

7. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification Assessment and Control, 4th Edition, Butterworth Heineman, 2012.

**OIC431**

**BLOCKCHAIN TECHNOLOGIES**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- This course is intended to study the basics of Blockchain technology.
- During this course the learner will explore various aspects of Blockchain technology like application in various domains.
- By implementing, learners will have idea about private and public Blockchain, and smart contract.

**UNIT I INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN 9**

Introduction to Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.

**UNIT II BITCOIN AND CRYPTOCURRENCY 9**

Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency.

**UNIT III INTRODUCTION TO ETHEREUM 9**

Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, , Transactions, Receiving Ethers, Smart Contracts.

**UNIT-IV INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING 10**

Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.

**UNIT V BLOCKCHAIN APPLICATIONS 8**

Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

After the completion of this course, student will be able to

**CO1:** Understand and explore the working of Blockchain technology

**CO2:** Analyze the working of Smart Contracts

**CO3:** Understand and analyze the working of Hyperledger

**CO4:** Apply the learning of solidity to build de-centralized apps on Ethereum

**CO5:** Develop applications on Blockchain

## REFERENCES:

1. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained", Second Edition, Packt Publishing, 2018.
2. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction" Princeton University Press, 2016
3. Antonopoulos, Mastering Bitcoin, O'Reilly Publishing, 2014. .
4. Antonopoulos and G. Wood, "Mastering Ethereum: Building Smart Contracts and Dapps", O'Reilly Publishing, 2018.
5. D. Drescher, Blockchain Basics. Apress, 2017.

**OIC432**

**DEEP LEARNING**

**L T P C**  
**3 0 0 3**

## COURSE OBJECTIVES:

- Develop and Train Deep Neural Networks.
- Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition
- Build and train RNNs, work with NLP and Word Embeddings
- The internal structure of LSTM and GRU and the differences between them
- The Auto Encoders for Image Processing

## UNIT I DEEP LEARNING CONCEPTS

**6**

Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. Early Neural Networks. How Deep Learning different from Machine Learning. Scalars. Vectors. Matrixes, Higher Dimensional Tensors. Manipulating Tensors. Vector Data. Time Series Data. Image Data. Video Data.

## UNIT II NEURAL NETWORKS

**9**

About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. Loss Functions. Data Pre-processing for neural networks, Feature Engineering. Overfitting and Underfitting. Hyperparameters.

## UNIT III CONVOLUTIONAL NEURAL NETWORK

**10**

About CNN. Linear Time Invariant. Image Processing Filtering. Building a convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Backpropagation Through the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions. Various Optimizers. LeNet, AlexNet, VGG16, ResNet. Transfer Learning with Image Data. Transfer Learning using Inception Oxford VGG Model, Google Inception Model, Microsoft ResNet Model. R-CNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO

## UNIT IV NATURAL LANGUAGE PROCESSING USING RNN

**10**

About NLP & its Toolkits. Language Modeling . Vector Space Model (VSM). Continuous Bag of Words (CBOW). Skip-Gram Model for Word Embedding. Part of Speech (PoS) Global Co-occurrence Statistics-based Word Vectors. Transfer Learning. Word2Vec. Global Vectors for Word

Representation GloVe. Backpropagation Through Time. Bidirectional RNNs (BRNN) . Long Short Term Memory (LSTM). Bi-directional LSTM. Sequence-to-Sequence Models (Seq2Seq). Gated recurrent unit GRU.

**UNIT V DEEP REINFORCEMENT & UNSUPERVISED LEARNING 10**

About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy Gradient Methods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding. Variational Auto Encoding. Generative Adversarial Networks. Autoencoders for Feature Extraction. Auto Encoders for Classification. Denoising Autoencoders. Sparse Autoencoders

**COURSE OUTCOMES:**

- CO1:** Feature Extraction from Image and Video Data
- CO2:** Implement Image Segmentation and Instance Segmentation in Images
- CO3:** Implement image recognition and image classification using a pretrained network (Transfer Learning)
- CO4:** Traffic Information analysis using Twitter Data
- CO5:** Autoencoder for Classification & Feature Extraction

**TOTAL : 45 PERIODS**

**REFERENCES**

1. Deep Learning A Practitioner’s Approach Josh Patterson and Adam Gibson O’Reilly Media, Inc.2017
2. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
3. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
4. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017
5. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017

**OME431 VIBRATION AND NOISE CONTROL STRATEGIES L T P C  
3 0 0 3**

**OBJECTIVES**

- To appreciate the basic concepts of vibration in damped and undamped systems
- To appreciate the basic concepts of noise, its effect on hearing and related terminology
- To use the instruments for measuring and analyzing the vibration levels in a body
- To use the instruments for measuring and analyzing the noise levels in a system
- To learn the standards of vibration and noise levels and their control techniques

**UNIT- I BASICS OF VIBRATION 9**

Introduction – Sources and causes of Vibration-Mathematical Models - Displacement, velocity and Acceleration - Classification of vibration: free and forced vibration, undamped and damped vibration, linear and non-linear vibration - Single Degree Freedom Systems - Vibration isolation - Determination of natural frequencies

**UNIT- II BASICS OF NOISE 9**

Introduction - Anatomy of human ear - Mechanism of hearing - Amplitude, frequency, wavelength and sound pressure level - Relationship between sound power, sound intensity and sound pressure level - Addition, subtraction and averaging decibel levels - sound spectra -Types of sound fields - Octave band analysis - Loudness.

**UNIT- III INSTRUMENTATION FOR VIBRATION MEASUREMENT 9**

Experimental Methods in Vibration Analysis.- Vibration Measuring Instruments - Selection of Sensors - Accelerometer Mountings - Vibration Exciters - Mechanical, Hydraulic, Electromagnetic and Electrodynamics – Frequency Measuring Instruments -. System Identification from Frequency Response -Testing for resonance and mode shapes

**UNIT- IV INSTRUMENTATION FOR NOISE MEASUREMENT AND ANALYSIS 9**

Microphones - Weighting networks - Sound Level meters, its classes and calibration - Noise measurements using sound level meters - Data Loggers - Sound exposure meters - Recording of noise - Spectrum analyser - Intensity meters - Energy density sensors - Sound source localization.

**UNIT- V METHODS OF VIBRATION CONTROL, SOURCES OF NOISE AND ITS CONTROL 9**

Specification of Vibration Limits – Vibration severity standards - Vibration as condition Monitoring Tool – Case Studies - Vibration Isolation methods - Dynamic Vibration Absorber – Need for Balancing - Static and Dynamic Balancing machines – Field balancing - Major sources of noise - Noise survey techniques – Measurement technique for vehicular noise - Road vehicles Noise standard – Noise due to construction equipment and domestic appliances – Industrial noise sources and its strategies – Noise control at the source – Noise control along the path – Acoustic Barriers – Noise control at the receiver -- Sound transmission through barriers – Noise reduction Vs Transmission loss - Enclosures

**TOTAL: 45 PERIODS**

**OUTCOMES:**

On Completion of the course the student will be able to

1. apply the basic concepts of vibration in damped and undamped systems
2. apply the basic concepts of noise and to understand its effects on systems
3. select the instruments required for vibration measurement and its analysis
4. select the instruments required for noise measurement and its analysis.
5. recognize the noise sources and to control the vibration levels in a body and to control noise under different strategies.

**REFERENCES:**

1. Singiresu S. Rao, "Mechanical Vibrations", Pearson Education Incorporated, 2017.
2. Graham Kelly. Sand Shashidhar K. Kudari, "Mechanical Vibrations", Tata McGraw –Hill Publishing Com. Ltd., 2007.
3. Ramamurti. V, "Mechanical Vibration Practice with Basic Theory", Narosa Publishing House, 2000.
4. William T. Thomson, "Theory of Vibration with Applications", Taylor & Francis, 2003.
5. G.K. Grover, "Mechanical Vibrations", Nem Chand and Bros.,Roorkee, 2014.
6. A.G. Ambekar, "Mechanical Vibrations and Noise Engineering", PHI Learning Pvt. Ltd., 2014.
7. David A. Bies and Colin H. Hansen, "Engineering Noise Control – Theory and Practice", Spon Press, London and New York, 2009.

## OME432 ENERGY CONSERVATION AND MANAGEMENT IN DOMESTIC SECTORS

|   |   |   |   |
|---|---|---|---|
| L | T | P | C |
| 3 | 0 | 0 | 3 |

### COURSE OBJECTIVES:

1. To learn the present energy scenario and the need for energy conservation.
2. To understand the different measures for energy conservation in utilities.
3. Acquaint students with principle theories, materials, and construction techniques to create energy efficient buildings.
4. To identify the energy demand and bridge the gap with suitable technology for sustainable habitat
5. To get familiar with the energy technology, current status of research and find the ways to optimize a system as per the user requirement

### UNIT I ENERGY SCENARIO 9

Primary energy resources - Sectorial energy consumption (domestic, industrial and other sectors), Energy pricing, Energy conservation and its importance, Energy Conservation Act-2001 and its features – Energy star rating.

### UNIT II HEATING, VENTILLATION & AIR CONDITIONING 9

Basics of Refrigeration and Air Conditioning – COP / EER / SEC Evaluation – SPV system design & optimization for Solar Refrigeration.

### UNIT III LIGHTING, COMPUTER, TV 9

Specification of Luminaries – Types – Efficacy – Selection & Application – Time Sensors – Occupancy Sensors – Energy conservation measures in computer – Television – Electronic devices.

### UNIT IV ENERGY EFFICIENT BUILDINGS 9

Conventional versus Energy efficient buildings – Landscape design – Envelope heat loss and heat gain – Passive cooling and heating – Renewable sources integration.

### UNIT V ENERGY STORAGE TECHNOLOGIES 9

Necessity & types of energy storage – Thermal energy storage – Battery energy storage, charging and discharging– Hydrogen energy storage & Super capacitors – energy density and safety issues – Applications.

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Understand technical aspects of energy conservation scenario.
2. Energy audit in any type for domestic buildings and suggest the conservation measures.
3. Perform building load estimates and design the energy efficient landscape system.
4. Gain knowledge to utilize an appliance/device sustainably.
5. Understand the status and current technological advancement in energy storage field.

### REFERENCES:

1. Yogi Goswami, Frank Kreith, Energy Efficiency and Renewable energy Handbook, CRC Press, 2016
2. ASHRAE Handbook 2020 – HVAC Systems & Equipment

3. Paolo Bertoldi, Andrea Ricci, Anibal de Almeida, Energy Efficiency in Household Appliances and Lighting, Conference proceedings, Springer, 2001
4. David A. Bainbridge, Ken Haggard, Kenneth L. Haggard, Passive Solar Architecture: Heating, Cooling, Ventilation, Daylighting, and More Using Natural Flows, Chelsea Green Publishing, 2011.
5. Guide book for National Certification Examination for Energy Managers and Energy Auditors  
(Could be downloaded from [www.energymanagertraining.com](http://www.energymanagertraining.com))
6. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002.
7. Robert Huggins, Energy Storage: Fundamentals, Materials and Applications, 2nd edition, Springer, 2015
8. Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion, Wiley publications, 2012.

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|---|--|----------------------------------|
| <b>OME433</b>   | <b>ADDITIVE MANUFACTURING</b>                  | <b>L T P C</b><br><b>3 0 0 3</b> |
| <b>UNIT I</b>   | <b>INTRODUCTION</b>                            | <b>9</b>                         |
| Need - Development - Rapid Prototyping Rapid Tooling – Rapid Manufacturing – Additive Manufacturing. AM Process Chain- Classification – Benefits.   |  |                                  |
| <b>UNIT II</b>  | <b>DESIGN FOR ADDITIVE MANUFACTURING</b>       | <b>9</b>                         |
| CAD Model Preparation - Part Orientation and Support Structure Generation -Model Slicing - Tool Path Generation Customized Design and Fabrication - Case Studies.   |  |                                  |
| <b>UNIT III</b>   | <b>VAT POLYMERIZATION</b>                      | <b>9</b>                         |
| Stereolithography Apparatus (SLA)- Materials -Process -Advantages Limitations- Applications. Digital Light Processing (DLP) - Materials – Process - Advantages - Applications. Multi Jet Modelling (MJM) - Principles - Process - Materials - Advantages and Limitations.   |  |                                  |
| <b>UNIT IV</b>  | <b>MATERIAL EXTRUSION AND SHEET LAMINATION</b> | <b>9</b>                         |
| Fused Deposition Modeling (FDM)- Process-Materials - Applications and Limitations. Sheet Lamination Process: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding – Thermal Bonding- Materials- Application and Limitation - Bio-Additive Manufacturing Computer Aided Tissue Engineering (CATE) – Case studies   |  |                                  |
| <b>POWDER BASED PROCESS</b>   |  |                                  |
| Selective Laser Sintering (SLS): Process –Mechanism– Typical Materials and Application- Multi Jet Fusion - Basic Principle-- Materials- Application and Limitation - Three Dimensional Printing - Materials -Process - Benefits and Limitations. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Materials – Process - Advantages and Applications. Beam Deposition Process: Laser Engineered Net Shaping (LENS)- Process -Material Delivery - Process Parameters - Materials -Benefits -Applications. |  |                                  |

## UNIT V CASE STUDIES AND OPPORTUNITIES ADDITIVE MANUFACTURING PROCESSES

9

Education and training - Automobile- pattern and mould - tooling - Building Printing-Bio Printing - medical implants -development of surgical tools Food Printing -Printing Electronics. Business Opportunities and Future Directions - Intellectual Property.

**TOTAL: 45 PERIODS**

### REFERENCES:

1. Andreas Gebhardt and Jan-Steffen Hötter "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing", Hanser publications, United States, 2015, ISBN: 978-1- 56990-582-1.
2. Ian Gibson, David W. Rosen and Brent Stucker "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", 2nd edition, Springer., United States, 2015, ISBN13: 978-1493921126.
3. Amit Bandyopadhyay and Susmita Bose, "Additive Manufacturing", 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590
4. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing", Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
5. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third edition, World Scientific Publishers, 2010.

**OME434**

**ELECTRIC VEHICLE TECHNOLOGY**

**L T P C**  
**3 0 0 3**

### UNIT I NEED FOR ELECTRIC VEHICLES

9

History and need for electric and hybrid vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies, comparison of diesel, petrol, electric and hybrid vehicles, limitations, technical challenges

### UNIT II ELECTRIC VEHICLE ARCHITECHTURE

9

Electric vehicle types, layout and power delivery, performance – traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, Concepts of hybrid electric drive train, architecture of series and parallel hybrid electric drive train, merits and demerits, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electric vehicles, Fuel cell vehicles.

### UNIT III ENERGY STORAGE

9

Batteries – types – lead acid batteries, nickel based batteries, and lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency, Battery modeling and equivalent circuit, battery charging and types, battery cooling, Ultra-capacitors, Flywheel technology, Hydrogen fuel cell, Thermal Management of the PEM fuel cell

### UNIT IV ELECTRIC DRIVES AND CONTROL

9

Types of electric motors – working principle of AC and DC motors, advantages and limitations, DC motor drives and control, Induction motor drives and control, PMSM and brushless DC motor - drives and control , AC and Switch reluctance motor drives and control – Drive system efficiency – Inverters – DC and AC motor speed controllers

**UNIT V DESIGN OF ELECTRIC VEHICLES****9**

Materials and types of production, Chassis skate board design, motor sizing, power pack sizing, component matching, Ideal gear box – Gear ratio, torque–speed characteristics, Dynamic equation of vehicle motion, Maximum tractive effort – Power train tractive effort Acceleration performance, rated vehicle velocity – maximum gradability, Brake performance, Electronic control system, safety and challenges in electric vehicles. Case study of Nissan leaf, Toyota Prius, tesla model 3, and Renault Zoe cars.

**TOTAL: 45 PERIODS****REFERENCES:**

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, 2<sup>nd</sup> edition CRC Press, 2011.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained - Wiley, 2003.
4. Ehsani, M, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2005

**OME435****NEW PRODUCT DEVELOPMENT**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

1. Applying the principles of generic development process; and understanding the organization structure for new product design and development.
2. Identifying opportunity and planning for new product design and development.
3. Conducting customer need analysis; and setting product specification for new product design and development.
4. Generating, selecting, and testing the concepts for new product design and development.
5. Applying the principles of Industrial design and prototype for new product design and development.

**UNIT I INTRODUCTION TO PRODUCT DESIGN & DEVELOPMENT****9**

Introduction – Characteristics of Successful Product Development – People involved in Product Design and Development – Duration and Cost of Product Development – The Challenges of Product Development – The Product Development Process – Concept Development: The Front-End Process – Adapting the Generic Product Development Process – Product Development Process Flows – Product Development Organizations.

**UNIT II OPPORTUNITY IDENTIFICATION & PRODUCT PLANNING****9**

Opportunity Identification: Definition – Types of Opportunities – Tournament Structure of Opportunity Identification – Effective Opportunity Tournaments – Opportunity Identification Process – Product Planning: Four types of Product Development Projects – The Process of Product Planning.

**UNIT III IDENTIFYING CUSTOMER NEEDS & PRODUCT SPECIFICATIONS****9**

Identifying Customer Needs: The Importance of Latent Needs – The Process of Identifying Customer Needs. Product Specifications: Definition – Time of Specifications Establishment –

Establishing Target Specifications – Setting the Final Specifications

**UNIT IV CONCEPT GENERATION, SELECTION & TESTING 9**

Concept Generation: Activity of Concept Generation – Structured Approach – Five step method of Concept Generation. Concept Selection: Methodology – Concept Screening and Concepts Scoring. Concept testing: Seven Step activities of concept testing.

**UNITV INDUSTRIAL DESIGN & PROTOTYPING 9**

Industrial Design: Need and Impact–Industrial Design Process. Prototyping – Principles of Prototyping – Prototyping Technologies – Planning for Prototypes.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

1. Apply the principles of generic development process; and understand the organization structure for new product design and development.
2. Identify opportunity and plan for new product design and development.
3. Conduct customer need analysis; and set product specification for new product design and development.
4. Generate, select, and test the concepts for new product design and development.
5. Apply the principles of Industrial design and prototype for design and develop new products.

**TEXT BOOK:**

1. Ulrich K.T., Eppinger S. D. and Anita Goyal, “Product Design and Development” McGraw-Hill Education; 7 edition, 2020.

**REFERENCES:**

1. Belz A., 36-Hour Course: “Product Development” McGraw-Hill, 2010.
2. Rosenthal S., “Effective Product Design and Development”, Business One Orwin, Homewood, 1992, ISBN1-55623-603-4.
3. Pugh.S, “Total Design Integrated Methods for Successful Product Engineering”, Addison Wesley Publishing, 1991, ISBN0-202-41639-5.
4. Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, PHI Learning, 2013.
5. Jamnia, A., Introduction to Product Design and Development for Engineers, CRC Press, 2018.

**OBA431**

**SUSTAINABLE MANAGEMENT**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- To provide students with fundamental knowledge of the notion of corporate sustainability.
- To determine how organizations impacts on the environment and socio-technical systems, the relationship between social and environmental performance and competitiveness, the approaches and methods.

|  |   |          |
|--|---|----------|
| <b>UNIT I</b>  | <b>MANAGEMENT OF SUSTAINABILITY</b>                                 | <b>9</b> |
| Management of sustainability -rationale and political trends: An introduction to sustainability management, International and European policies on sustainable development, theoretical pillars in sustainability management studies.  |   |          |
| <b>UNIT II</b>   | <b>CORPORATE SUSTAINABILITY AND RESPONSIBILITY</b>                  | <b>9</b> |
| Corporate sustainability parameter, corporate sustainability institutional framework, integration of sustainability into strategic planning and regular business practices, fundamentals of stakeholder engagement.  |   |          |
| <b>UNIT III</b>  | <b>SUSTAINABILITY MANAGEMENT: STRATEGIES AND APPROACHES</b>         | <b>9</b> |
| Corporate sustainability management and competitiveness: Sustainability-oriented corporate strategies, markets and competitiveness, Green Management between theory and practice, Sustainable Consumption and Green Marketing strategies, Environmental regulation and strategic postures; Green Management approaches and tools; Green engineering: clean technologies and innovation processes; Sustainable Supply Chain Management and Procurement. |   |          |
| <b>UNIT IV</b>   | <b>SUSTAINABILITY AND INNOVATION</b>                                | <b>9</b> |
| Socio-technical transitions and sustainability, Sustainable entrepreneurship, Sustainable pioneers in green market niches, Smart communities and smart specializations.  |   |          |
| <b>UNIT V</b>  | <b>SUSTAINABLE MANAGEMENT OF RESOURCES, COMMODITIES AND COMMONS</b> | <b>9</b> |
| Energy management, Water management, Waste management, Wild Life Conservation, Emerging trends in sustainable management, Case Studies.  |   |          |

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- CO1: An understanding of sustainability management as an approach to aid in evaluating and minimizing environmental impacts while achieving the expected social impact.
- CO2: An understanding of corporate sustainability and responsible Business Practices
- CO3: Knowledge and skills to understand, to measure and interpret sustainability performances.
- CO4: Knowledge of innovative practices in sustainable business and community management
- CO5: Deep understanding of sustainable management of resources and commodities

**REFERENCES:**

1. Daddi, T., Iraldo, F., Testa, Environmental Certification for Organizations and Products: Management, 2015
2. Christian N. Madu, Handbook of Sustainability Management 2012
3. Petra Molthan-Hill, The Business Student's Guide to Sustainable Management: Principles and Practice, 2014
4. Margaret Robertson, Sustainability Principles and Practice, 2014
5. Peter Rogers, An Introduction to Sustainable Development, 2006

**COURSE OBJECTIVES**

- To familiarize students with the theory and practice of small business management.
- To learn the legal issues faced by small business and how they impact operations.

**UNIT I INTRODUCTION TO SMALL BUSINESS 9**

Creation, Innovation, entrepreneurship and small business - Defining Small Business –Role of Owner – Manager – government policy towards small business sector –elements of entrepreneurship –evolution of entrepreneurship –Types of Entrepreneurship – social, civic, corporate - Business life cycle - barriers and triggers to new venture creation – process to assist start ups – small business and family business.

**UNIT II SCREENING THE BUSINESS OPPORTUNITY AND FORMULATING THE BUSINESS PLAN 9**

Concepts of opportunity recognition; Key factors leading to new venture failure; New venture screening process; Applying new venture screening process to the early stage small firm Role planning in small business – importance of strategy formulation – management skills for small business creation and development.

**UNIT III BUILDING THE RIGHT TEAM AND MARKETING STRATEGY 9**

Management and Leadership – employee assessments – Tuckman’s stages of group development - The entrepreneurial process model - Delegation and team building - Comparison of HR management in small and large firms - Importance of coaching and how to apply a coaching model.

Marketing within the small business - success strategies for small business marketing - customer delight and business generating systems, - market research, - assessing market performance- sales management and strategy - the marketing mix and marketing strategy.

**UNIT IV FINANCING SMALL BUSINESS 9**

Main sources of entrepreneurial capital; Nature of ‘bootstrap’ financing - Difference between cash and profit - Nature of bank financing and equity financing - Funding-equity gap for small firms. Importance of working capital cycle - Calculation of break-even point - Power of gross profit margin- Pricing for profit - Credit policy issues and relating these to cash flow management and profitability.

**UNIT V VALUING SMALL BUSINESS AND CRISIS MANAGEMENT 9**

Causes of small business failure - Danger signals of impending trouble - Characteristics of poorly performing firms - Turnaround strategies - Concept of business valuation - Different valuation measurements - Nature of goodwill and how to measure it - Advantages and disadvantages of buying an established small firm - Process of preparing a business for sale.

**TOTAL: 45 PERIODS****COURSE OUTCOMES**

CO1. Familiarise the students with the concept of small business

CO2. In depth knowledge on small business opportunities and challenges

CO3. Ability to devise plans for small business by building the right skills and marketing strategies



## REFERENCES

1. V. Sople Vinod, Managing Intellectual Property by (Prentice hall of India Pvt.Ltd), 2006.
2. Intellectual Property rights and copyrights, EssEss Publications.
3. Primer, R. Anita Rao and Bhanoji Rao, Intellectual Property Rights, Lastain Book company.
4. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2006.
5. WIPO Intellectual Property Hand book.

**OBA434**

**ETHICAL MANAGEMENT**

**L T P C**  
**3 0 0 3**

### COURSE OBJECTIVE

➤ To help students develop knowledge and competence in ethical management and decision making in organizational contexts.

#### **UNIT I ETHICS AND SOCIETY**

**9**

Ethical Management- Definition, Motivation, Advantages-Practical implications of ethical management. Managerial ethics, professional ethics, and social Responsibility-Role of culture and society's expectations- Individual and organizational responsibility to society and the community.

#### **UNIT II ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS**

**9**

Managing in an ethical crisis, the nature of a crisis, ethics in crisis management, discuss case studies, analyze real-world scenarios, develop ethical management skills, knowledge, and competencies. Proactive crisis management.

#### **UNIT III STAKEHOLDERS IN ETHICAL MANAGEMENT**

**9**

Stakeholders in ethical management, identifying internal and external stakeholders, nature of stakeholders, ethical management of various kinds of stakeholders: customers (product and service issues), employees (leadership, fairness, justice, diversity) suppliers, collaborators, business, community, the natural environment (the sustainability imperative, green management, Contemporary issues).

#### **UNIT IV INDIVIDUAL VARIABLES IN ETHICAL MANJAGEMENT**

**9**

Understanding individual variables in ethics, managerial ethics, concepts in ethical psychology-ethical awareness, ethical courage, ethical judgment, ethical foundations, ethical emotions/intuitions/intensity. Utilization of these concepts and competencies for ethical decision-making and management.

#### **UNIT V PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS**

**9**

Ethical management in practice, development of techniques and skills, navigating challenges and dilemmas, resolving issues and preventing unethical management proactively. Role modelling and creating a culture of ethical management and human flourishing.

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES

CO1: Role modelling and influencing the ethical and cultural context.

- CO2: Respond to ethical crises and proactively address potential crises situations.
- CO3: Understand and implement stakeholder management decisions.
- CO4: Develop the ability, knowledge, and skills for ethical management.
- CO5: Develop practical skills to navigate, resolve and thrive in management situations

## REFERENCES

1. Brad Agle, Aaron Miller, Bill O' Rourke, The Business Ethics Field Guide: the essential companion to leading your career and your company, 2016.
2. Steiner & Steiner, Business, Government & Society: A managerial Perspective, 2011.
3. Lawrence & Weber, Business and Society: Stakeholders, Ethics, Public Policy, 2020.

**ET4251**

**IoT FOR SMART SYSTEMS**

**L T P C**  
**3 0 0 3**

### COURSE OBJECTIVES:

1. To study about **Internet of Things** technologies and its role in real time applications.
2. To introduce the infrastructure required for IoT
3. To familiarize the accessories and communication techniques for IoT.
4. To provide insight about the embedded processor and sensors required for IoT
5. To familiarize the different platforms and Attributes for IoT

### UNIT I INTRODUCTION TO INTERNET OF THINGS

**9**

Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IoT applications, Trends and implications.

### UNIT II IOT ARCHITECTURE

**9**

IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture, IoT standards, Cloud computing for IoT, Bluetooth, Bluetooth Low Energy beacons.

### UNIT III PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT

**9**

#### PROTOCOLS:

NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIE GSM, CDMA, LTE, GPRS, small cell.

**Wireless technologies for IoT:** WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends.

### UNIT IV IOT PROCESSORS

**9**

**Services/Attributes:** Big-Data Analytics for IOT, Dependability, Interoperability, Security, Maintainability.

**Embedded processors for IOT :** Introduction to Python programming -Building IOT with RASPBERRY PI and Arduino.

## UNIT V CASE STUDIES

9

Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Analyze the concepts of IoT and its present developments.

CO2: Compare and contrast different platforms and infrastructures available for IoT

CO3: Explain different protocols and communication technologies used in IoT

CO4: Analyze the big data analytic and programming of IoT

CO5: Implement IoT solutions for smart applications

### REFERENCES:

1. ArshdeepBahga and VijaiMadiseti : A Hands-on Approach "Internet of Things",Universities Press 2015.
2. Oliver Hersent , David Boswarthick and Omar Elloumi " The Internet of Things", Wiley,2016.
3. Samuel Greengard, " The Internet of Things", The MIT press, 2015.
4. Adrian McEwen and Hakim Cassimally"Designing the Internet of Things "Wiley,2014.
5. Jean- Philippe Vasseur, Adam Dunkels, "Interconnecting Smart Objects with IP: The Next Internet" Morgan Kuffmann Publishers, 2010.
6. Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things", John Wiley and sons, 2014.
7. Lingyang Song/DusitNiyato/ Zhu Han/ Ekram Hossain," Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.
8. OvidiuVermesan and Peter Friess (Editors), "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers Series in Communication, 2013.
9. Vijay Madiseti , ArshdeepBahga, "Internet of Things (A Hands on-Approach)", 2014.
10. Zach Shelby, Carsten Bormann, "6LoWPAN: The Wireless Embedded Internet", John Wiley and sons, 2009.
11. Lars T.Berger and Krzysztof Iniewski, "Smart Grid applications, communications and security", Wiley, 2015.
12. JanakaEkanayake, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, " Smart Grid Technology and Applications", Wiley, 2015.
13. UpenaDalal,"Wireless Communications & Networks,Oxford,2015.

**ET4072**

**MACHINE LEARNING AND DEEP LEARNING**

**L T P C**

**3 0 0 3**

### COURSE OBJECTIVES:

The course is aimed at

1. Understanding about the learning problem and algorithms
2. Providing insight about neural networks
3. Introducing the machine learning fundamentals and significance
4. Enabling the students to acquire knowledge about pattern recognition.

5. Motivating the students to apply deep learning algorithms for solving real life problems.

**UNIT I LEARNING PROBLEMS AND ALGORITHMS**

**9**

Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

**UNIT II NEURAL NETWORKS**

**9**

Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning.

**UNIT III MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS**

**9**

Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering.

**UNIT IV DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS**

**9**

Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.

**UNIT V DEEP LEARNING: RNNs, AUTOENCODERS AND GANS**

**9**

State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES (CO):**

At the end of the course the student will be able to

CO1 : Illustrate the categorization of machine learning algorithms.

CO2: Compare and contrast the types of neural network architectures, activation functions

CO3: Acquaint with the pattern association using neural networks

CO4: Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks

CO5: Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.

**REFERENCES:**

1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2. Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.
3. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
4. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.

5. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

**PX4012**

**RENEWABLE ENERGY TECHNOLOGY**

**L T P C**  
**3 0 0 3**

**OBJECTIVES:**

To impart knowledge on

- Different types of renewable energy technologies
- Standalone operation, grid connected operation of renewable energy systems

**UNIT I INTRODUCTION**

**9**

Classification of energy sources – Co<sub>2</sub> Emission - Features of Renewable energy - Renewable energy scenario in India -Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment Per Capital Consumption - CO<sub>2</sub> Emission - importance of renewable energy sources, Potentials – Achievements– Applications.

**UNIT II SOLAR PHOTOVOLTAICS**

**9**

Solar Energy: Sun and Earth-Basic Characteristics of solar radiation- angle of sunrays on solar collector-Estimating Solar Radiation Empirically - Equivalent circuit of PV Cell- Photovoltaic cell-characteristics: P-V and I-V curve of cell-Impact of Temperature and Insolation on I-V characteristics-Shading Impacts on I-V characteristics-Bypass diode -Blocking diode.

**UNIT III PHOTOVOLTAIC SYSTEM DESIGN**

**9**

Block diagram of solar photo voltaic system : Line commutated converters (inversion mode) - Boost and buck-boost converters - selection of inverter, battery sizing, array sizing - PV systems classification- standalone PV systems - Grid tied and grid interactive inverters- grid connection issues.

**UNIT IV WIND ENERGY CONVERSION SYSTEMS**

**9**

Origin of Winds: Global and Local Winds- Aerodynamics of Wind turbine-Derivation of Betz's limit-Power available in wind-Classification of wind turbine: Horizontal Axis wind turbine and Vertical axis wind turbine- Aerodynamic Efficiency-Tip Speed-Tip Speed Ratio-Solidity-Blade Count-Power curve of wind turbine - Configurations of wind energy conversion systems: Type A, Type B, Type C and Type D Configurations- Grid connection Issues - Grid integrated SCIG and PMSG based WECS.

**UNIT V OTHER RENEWABLE ENERGY SOURCES**

**9**

Qualitative study of different renewable energy resources: ocean, Biomass, Hydrogen energy systems, Fuel cells, Ocean Thermal Energy Conversion (OTEC), Tidal and wave energy, Geothermal Energy Resources.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

After completion of this course, the student will be able to:

- CO1: Demonstrate the need for renewable energy sources.
- CO2: Develop a stand-alone photo voltaic system and implement a maximum power point tracking in the PV system.

- CO3: Design a stand-alone and Grid connected PV system.  
 CO4: Analyze the different configurations of the wind energy conversion systems.  
 CO5: Realize the basic of various available renewable energy sources

**REFERENCES:**

1. S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford University Press, 2009.
2. Rai. G.D, “Non conventional energy sources”, Khanna publishes, 1993.
3. Rai. G.D,” Solar energy utilization”, Khanna publishes, 1993.
4. Chetan Singh Solanki, “Solar Photovoltaics: Fundamentals, Technologies and Applications”, PHI Learning Private Limited, 2012.
5. John Twideu and Tony Weir, “Renewal Energy Resources” BSP Publications, 2006
6. Gray, L. Johnson, “Wind energy system”, prentice hall of India, 1995.
7. B.H.Khan, " Non-conventional Energy sources", , McGraw-hill, 2<sup>nd</sup> Edition, 2009.
8. Fang Lin Luo Hong Ye, " Renewable Energy systems", Taylor & Francis Group,2013.

**PS4093**

**SMART GRID**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES**

- To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To know about the function of smart grid.
- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high performance computing for Smart Grid applications
- To get familiarized with the communication networks for Smart Grid applications

**UNIT I INTRODUCTION TO SMART GRID**

**9**

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Comparison of Micro grid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study.

**UNIT II SMART GRID TECHNOLOGIES**

**9**

Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts.

**UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE**

**9**

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU) & their application for monitoring & protection. Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

**UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID****9**

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

**Unit V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9**

Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

**TOTAL : 45 PERIODS****COURSE OUTCOME:**

Students able to

CO1: Relate with the smart resources, smart meters and other smart devices.

CO2: Explain the function of Smart Grid.

CO3: Experiment the issues of Power Quality in Smart Grid.

CO4: Analyze the performance of Smart Grid.

CO5: Recommend suitable communication networks for smart grid applications

**REFERENCES**

1. Stuart Borlase 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanaage, Jianzhong Wu, Akihiko Yokoyama, 'Smart Grid: Technology and Applications', Wiley, 2012.
3. Mini S. Thomas, John D McDonald, 'Power System SCADA and Smart Grids', CRC Press, 2015
4. Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart Grids', Springer, 2014
5. SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.

**CP4391****SECURITY PRACTICES****L T P C****3 0 0 3****COURSE OBJECTIVES:**

- To learn the core fundamentals of system and web security concepts
- To have through understanding in the security concepts related to networks
- To deploy the security essentials in IT Sector
- To be exposed to the concepts of Cyber Security and cloud security
- To perform a detailed study of Privacy and Storage security and related Issues

**UNIT I SYSTEM SECURITY****9**

Model of network security – Security attacks, services and mechanisms – OSI security architecture -A Cryptography primer- Intrusion detection system- Intrusion Prevention system - Security web applications- Case study: OWASP - Top 10 Web Application Security Risks.

**UNIT II NETWORK SECURITY 9**  
Internet Security - Intranet security- Local Area Network Security - Wireless Network Security - Wireless Sensor Network Security- Cellular Network Security - Mobile security - IOT security - Case Study - Kali Linux.

**UNIT III SECURITY MANAGEMENT 9**  
Information security essentials for IT Managers- Security Management System - Policy Driven System Management- IT Security - Online Identity and User Management System. Case study: Metasploit

**UNIT IV CYBER SECURITY AND CLOUD SECURITY 9**  
Cyber Forensics- Disk Forensics – Network Forensics – Wireless Forensics – Database Forensics – Malware Forensics – Mobile Forensics – Email Forensics- Best security practices for automate Cloud infrastructure management – Establishing trust in IaaS, PaaS, and SaaS Cloud types. Case study: DVWA

**UNIT V PRIVACY AND STORAGE SECURITY 9**  
Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies- privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- CO1:** Understand the core fundamentals of system security
- CO2:** Apply the security concepts to wired and wireless networks
- CO3:** Implement and Manage the security essentials in IT Sector
- CO4:** Explain the concepts of Cyber Security and Cyber forensics
- CO5:** Be aware of Privacy and Storage security Issues.

**REFERENCES**

1. John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017
2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022
3. Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019
4. Mayor, K.K.Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for Penetration Testing, Exploit Development and Vulnerability Research, Syngress publications, Elsevier, 2007. ISBN : 978-1-59749-074-0
5. John Sammons, "The Basics of Digital Forensics- The Primer for Getting Started in Digital Forensics", Syngress, 2012
6. Cory Altheide and Harlan Carvey, "Digital Forensics with Open Source Tools", 2011 Syngress, ISBN: 9781597495875.
7. Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.

**COURSE OBJECTIVES:**

- To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution
- To understand the architecture, infrastructure and delivery models of cloud computing.
- To explore the roster of AWS services and illustrate the way to make applications in AWS
- To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
- To develop the cloud application using various programming model of Hadoop and Aneka

**UNIT I VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE 6**

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines –Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization –Management Virtualization — Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization- Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – virtual clusters and Resource Management – Virtualization for data center automation

**UNIT II CLOUD PLATFORM ARCHITECTURE 12**

Cloud Computing: Definition, Characteristics - Cloud deployment models: public, private, hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software- A Generic Cloud Architecture Design – Layered cloud Architectural Development – Architectural Design Challenges

**UNIT III AWS CLOUD PLATFORM - IAAS 9**

**Amazon Web Services:** AWS Infrastructure- AWS API- AWS Management Console - Setting up AWS Storage - Stretching out with Elastic Compute Cloud - Elastic Container Service for Kubernetes- AWS Developer Tools: AWS Code Commit, AWS Code Build, AWS Code Deploy, AWS Code Pipeline, AWS code Star - AWS Management Tools: Cloud Watch, AWS Auto Scaling, AWS control Tower, Cloud Formation, Cloud Trail, AWS License Manager

**UNIT IV PAAS CLOUD PLATFORM 9**

Windows Azure: Origin of Windows Azure, Features, The Fabric Controller – First Cloud APP in Windows Azure- Service Model and Managing Services: Definition and Configuration, Service runtime API- Windows Azure Developer Portal- Service Management API- Windows Azure Storage Characteristics-Storage Services- REST API- Blops

**UNIT V PROGRAMMING MODEL 9**

Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job –Developing Map Reduce Applications - Design of Hadoop file system –Setting up Hadoop Cluster- Aneka: Cloud Application Platform, Thread Programming, Task Programming and Map-Reduce Programming in Aneka

**TOTAL: 45 PERIODS**

## **COURSE OUTCOMES:**

**CO1:** Employ the concepts of virtualization in the cloud computing

**CO2:** Identify the architecture, infrastructure and delivery models of cloud computing

**CO3:** Develop the Cloud Application in AWS platform

**CO4:** Apply the concepts of Windows Azure to design Cloud Application

**CO5:** Develop services using various Cloud computing programming models.

## **REFERENCES**

1. Bernard Golden, Amazon Web Service for Dummies, John Wiley & Sons, 2013.
2. Raoul Alongi, AWS: The Most Complete Guide to Amazon Web Service from Beginner to Advanced Level, Amazon Asia- Pacific Holdings Private Limited, 2019.
3. Sriram Krishnan, Programming: Windows Azure, O'Reilly, 2010.
4. Rajkumar Buyya, Christian Vacchiola, S.Thamarai Selvi, Mastering Cloud Computing , McGraw Hill Education (India) Pvt. Ltd., 2013.
5. Danielle Ruest, Nelson Ruest, —Virtualization: A Beginner's Guidell, McGraw-Hill Osborne Media, 2009.
6. Jim Smith, Ravi Nair , "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
7. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
8. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.
9. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.

**IF4072**

**DESIGN THINKING**

**L T P C**  
**3 0 0 3**

## **COURSE OBJECTIVES:**

- To provide a sound knowledge in UI & UX
- To understand the need for UI and UX
- Research Methods used in Design
- Tools used in UI & UX
- Creating a wireframe and prototype

### **UNIT I**

#### **UX LIFECYCLE TEMPLATE**

**8**

Introduction. A UX process lifecycle template. Choosing a process instance for your project. The system complexity space. Meet the user interface team. Scope of UX presence within the team. More about UX lifecycles. Business Strategy. Value Innovation. Validated User Research. Killer UX Design. The Blockbuster Value Proposition. What Is a Value Proposition?.

### **UNIT II**

#### **CONTEXTUAL INQUIRY**

**10**

The system concept statement. User work activity data gathering. Look for emotional aspects of work practice. Abridged contextual inquiry process. Data-driven vs. model-driven inquiry. Organizing concepts: work roles and flow model. Creating and managing work activity notes.

Constructing your work activity affinity diagram (WAAD). Abridged contextual analysis process. History of affinity diagrams.

**UNIT III DESIGN THINKING, IDEATION, AND SKETCHING 9**

Design-informing models: second span of the bridge . Some general “how to” suggestions. A New example domain: slideshow presentations. User models. Usage models. Work environment models. Barrier summaries. Model consolidation. Protecting your sources. Abridged methods for design-informing models extraction. Design paradigms. Design thinking. Design perspectives. User personas. Ideation. Sketching

**UNIT IV UX GOALS, METRICS, AND TARGETS 8**

Introduction. UX goals. UX target tables. Work roles, user classes, and UX goals. UX measures. Measuring instruments. UX metrics. Baseline level. Target level. Setting levels. Observed results. Practical tips and cautions for creating UX targets. How UX targets help manage the user experience engineering process.

**UNIT V ANALYSING USER EXPERIENCE 10**

Sharpening Your Thinking Tools. UX Research and Strength of Evidence. Agile Personas. How to Prioritize Usability Problems. Creating Insights, Hypotheses and Testable Design Ideas. How to Manage Design Projects with User Experience Metrics. Two Measures that Will Justify Any Design Change. Evangelizing UX Research. How to Create a User Journey Map. Generating Solutions to Usability Problems. Building UX Research Into the Design Studio Methodology. Dealing with Common objections to UX Research. The User Experience Debrief Meeting. Creating a User Experience Dashboard.

**SUGGESTED ACTIVITIES:**

- 1: Hands on Design Thinking process for a product
- 2: Defining the Look and Feel of any new Project
- 3: Create a Sample Pattern Library for that product (Mood board, Fonts, Colors based on UI principles)
- 4: Identify a customer problem to solve.
- 5: Conduct end-to-end user research - User research, creating personas, Ideation process (User stories, Scenarios), Flow diagrams, Flow Mapping

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

- CO1:** Build UI for user Applications
- CO2:** Use the UI Interaction behaviors and principles
- CO3:** Evaluate UX design of any product or application
- CO4:** Demonstrate UX Skills in product development
- CO5:** Implement Sketching principles

**REFERENCES**

1. UX for Developers: How to Integrate User-Centered Design Principles Into Your Day-to-Day Development Work, Westley Knight. Apress, 2018
2. The UX Book: Process and Guidelines for Ensuring a Quality User Experience, Rex Hartson, Pardha Pyla. Morgan Kaufmann, 2012

3. UX Fundamentals for Non-UX Professionals: User Experience Principles for Managers, Writers, Designers, and Developers, Edward Stull. Apress, 2018
4. Lean UX: Designing Great Products with Agile Teams, Gothelf, Jeff, Seiden, and Josh. O'Reilly Media, 2016
5. Designing UX: Prototyping: Because Modern Design is Never Static, Ben Coleman, and Dan Goodwin. SitePoint, 2017

**MU4153**

**PRINCIPLES OF MULTIMEDIA**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To get familiarity with gamut of multimedia and its significance
- To acquire knowledge in multimedia components.
- To acquire knowledge about multimedia tools and authoring.
- To acquire knowledge in the development of multimedia applications.
- To explore the latest trends and technologies in multimedia

**UNIT I INTRODUCTION**

**9**

Introduction to Multimedia – Characteristics of Multimedia Presentation – Multimedia Components – Promotion of Multimedia Based Components – Digital Representation – Media and Data Streams – Multimedia Architecture – Multimedia Documents, Multimedia Tasks and Concerns, Production, sharing and distribution, Hypermedia, WWW and Internet, Authoring, Multimedia over wireless and mobile networks.

**Suggested Activities:**

1. Flipped classroom on media Components.
2. External learning – Interactive presentation.

**Suggested Evaluation Methods:**

1. Tutorial – Handling media components
2. Quizzes on different types of data presentation.

**UNIT II ELEMENTS OF MULTIMEDIA**

**9**

Text-Types, Font, Unicode Standard, File Formats, Graphics and Image data representations – data types, file formats, color models; video – color models in video, analog video, digital video, file formats, video display interfaces, 3D video and TV: Audio – Digitization, SNR, SQNR, quantization, audio quality, file formats, MIDI; Animation- Key Frames and Tweening, other Techniques, 2D and 3D Animation.

**Suggested Activities:**

1. Flipped classroom on different file formats of various media elements.
2. External learning – Adobe after effects, Adobe Media Encoder, Adobe Audition.

**Suggested Evaluation Methods:**

1. Demonstration on after effects animations.
2. Quizzes on file formats and color models.

### **UNIT III                      MULTIMEDIA TOOLS**

**9**

Authoring Tools – Features and Types – Card and Page Based Tools – Icon and Object Based Tools – Time Based Tools – Cross Platform Authoring Tools – Editing Tools – Painting and Drawing Tools – 3D Modeling and Animation Tools – Image Editing Tools – Sound Editing Tools – Digital Movie Tools.

#### **Suggested Activities:**

1. Flipped classroom on multimedia tools.
2. External learning – Comparison of various authoring tools.

#### **Suggested Evaluation Methods:**

1. Tutorial – Audio editing tool.
2. Quizzes on animation tools.

### **UNIT IV                      MULTIMEDIA SYSTEMS**

**9**

Compression Types and Techniques: CODEC, Text Compression: GIF Coding Standards, JPEG standard – JPEG 2000, basic audio compression – ADPCM, MPEG Psychoacoustics, basic Video compression techniques – MPEG, H.26X – Multimedia Database System – User Interfaces – OS Multimedia Support – Hardware Support – Real Time Protocols – Play Back Architectures – Synchronization – Document Architecture – Hypermedia Concepts: Hypermedia Design – Digital Copyrights, Content analysis.

#### **Suggested Activities:**

1. Flipped classroom on concepts of multimedia hardware architectures.
2. External learning – Digital repositories and hypermedia design.

#### **Suggested Evaluation Methods:**

1. Quizzes on multimedia hardware and compression techniques.
2. Tutorial – Hypermedia design.

### **UNIT V   MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS**

**9**

ADDIE Model – Conceptualization – Content Collection – Storyboard–Script Authoring Metaphors – Testing – Report Writing – Documentation. Multimedia for the web and mobile platforms. Virtual Reality, Internet multimedia content distribution, Multimedia Information sharing – social media sharing, cloud computing for multimedia services, interactive cloud gaming. Multimedia information retrieval.

#### **Suggested Activities:**

1. External learning – Game consoles.
2. External learning – VRML scripting languages.

#### **Suggested Evaluation Methods:**

1. Demonstration of simple interactive games.
2. Tutorial – Simple VRML program.

**TOTAL : 45 PERIODS**

#### **COURSE OUTCOMES:**

**CO1:**Handle the multimedia elements effectively.

**CO2:**Articulate the concepts and techniques used in multimedia applications.

**CO3:**Develop effective strategies to deliver Quality of Experience in multimedia applications.

**CO4:**Design and implement algorithms and techniques applied to multimedia objects.

**CO5:**Design and develop multimedia applications following software engineering models.

## REFERENCES:

1. Li, Ze-Nian, Drew, Mark, Liu, Jiangchuan, "Fundamentals of Multimedia", Springer, Third Edition, 2021.
2. Prabhat K. Andleigh, Kiran Thakrar, "MULTIMEDIA SYSTEMS DESIGN", Pearson Education, 2015.
3. Gerald Friedland, Ramesh Jain, "Multimedia Computing", Cambridge University Press, 2018. (digital book)
4. Ranjan Parekh, "Principles of Multimedia", Second Edition, McGraw-Hill Education, 2017

| <b>CX4016</b>  | <b>ENVIRONMENTAL SUSTAINABILITY</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b>                  |
|--|-------------------------------------|----------|----------|----------|---------------------------|
|  |                                     | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b>                  |
| <b>UNIT I</b>  | <b>INTRODUCTION</b>                 |          |          |          | <b>9</b>                  |
| Valuing the Environment: Concepts, Valuing the Environment: Methods, Property Rights, Externalities, and Environmental Problems                              |                                     |          |          |          |                           |
| <b>UNIT II</b>   | <b>CONCEPT OF SUSTAINABILITY</b>    |          |          |          | <b>9</b>                  |
| Sustainable Development: Defining the Concept, the Population Problem, Natural Resource Economics: An Overview, Energy, Water, Agriculture                   |                                     |          |          |          |                           |
| <b>UNIT III</b>  | <b>SIGNIFICANCE OF BIODIVERSITY</b> |          |          |          | <b>9</b>                  |
| Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary - Source Local Air Pollution, Acid Rain and Atmospheric Modification, Transportation |                                     |          |          |          |                           |
| <b>UNIT IV</b>   | <b>POLLUTION IMPACTS</b>            |          |          |          | <b>9</b>                  |
| Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes, Global Warming.   |                                     |          |          |          |                           |
| <b>UNIT V</b>  | <b>ENVIRONMENTAL ECONOMICS</b>      |          |          |          | <b>9</b>                  |
| Development, Poverty, and the Environment, Visions of the Future, Environmental economics and policy by Tom Tietenberg, Environmental Economics              |                                     |          |          |          |                           |
|  |                                     |          |          |          | <b>TOTAL : 45 PERIODS</b> |

## REFERENCES

1. Andrew Hoffman, Competitive Environmental Strategy - A Guide for the Changing Business Landscape, Island Press.
2. Stephen Doven, Environment and Sustainability Policy: Creation, Implementation, Evaluation, the Federation Press, 2005
3. Robert Brinkmann., Introduction to Sustainability, Wiley-Blackwell., 2016
4. Niko Roorda., Fundamentals of Sustainable Development, 3rd Edn, Routledge, 2020
5. Bhavik R Bakshi., Sustainable Engineering: Principles and Practice, Cambridge University Press, 2019

**TX4092**

**TEXTILE REINFORCED COMPOSITES**

**L T P C  
3 0 0 3**

**UNIT I REINFORCEMENTS**

**9**

Introduction – composites –classification and application; reinforcements- fibres and its properties; preparation of reinforced materials and quality evaluation; preforms for various composites

**UNIT II MATRICES**

**9**

Preparation, chemistry, properties and applications of thermoplastic and thermoset resins; mechanism of interaction of matrices and reinforcements; optimization of matrices

**UNIT III COMPOSITE MANUFACTURING**

**9**

Classification; methods of composites manufacturing for both thermoplastics and thermosets- Hand layup, Filament Winding, Resin transfer moulding, prepregs and autoclave moulding, pultrusion, vacuum impregnation methods, compression moulding; post processing of composites and composite design requirements

**UNIT IV TESTING**

**9**

Fibre volume and weight fraction, specific gravity of composites, tensile, flexural, impact, compression, inter laminar shear stress and fatigue properties of thermoset and thermoplastic composites.

**UNIT V MECHANICS**

**9**

Micro mechanics, macro mechanics of single layer, macro mechanics of laminate, classical lamination theory, failure theories and prediction of inter laminar stresses using at ware

**TOTAL: 45 PERIODS**

**REFERENCES**

1. BorZ.Jang, "Advanced Polymer composites", ASM International, USA, 1994.
2. Carlsson L.A. and Pipes R.B., "Experimental Characterization of advanced composite Materials", Second Edition, CRC Press, New Jersey, 1996.
3. George Lubin and Stanley T. Peters, "Handbook of Composites", Springer Publications, 1998.
4. Mel. M. Schwartz, "Composite Materials", Vol. 1 & 2, Prentice Hall PTR, New Jersey, 1997.
5. Richard M. Christensen, "Mechanics of composite materials", Dover Publications, 2005.
6. Sanjay K. Mazumdar, "Composites Manufacturing: Materials, Product, and Process Engineering", CRC Press, 2001

**NT4002**

**NANOCOMPOSITE MATERIALS**

**L T P C  
3 0 0 3**

**UNIT I BASICS OF NANOCOMPOSITES**

**9**

Nomenclature, Properties, features and processing of nanocomposites. Sample Preparation and Characterization of Structure and Physical properties. Designing, stability and mechanical properties and applications of super hard nanocomposites.

**UNIT II METAL BASED NANOCOMPOSITES 9**  
 Metal-metal nanocomposites, some simple preparation techniques and their properties. Metal-Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Core-Shell structured nanocomposites

**UNIT III POLYMER BASED NANOCOMPOSITES 9**  
 Preparation and characterization of diblock Copolymer based nanocomposites; Polymer Carbon nanotubes based composites, their mechanical properties, and industrial possibilities.

**UNIT IV NANOCOMPOSITE FROM BIOMATERIALS 9**  
 Natural nanocomposite systems - spider silk, bones, shells; organic-inorganic nanocomposite formation through self-assembly. Biomimetic synthesis of nanocomposites material; Use of synthetic nanocomposites for bone, teeth replacement.

**UNIT V NANOCOMPOSITE TECHNOLOGY 9**  
 Nanocomposite membrane structures- Preparation and applications. Nanotechnology in Textiles and Cosmetics-Nano-fillers embedded polypropylene fibers – Soil repellence, Lotus effect - Nano finishing in textiles (UV resistant, anti-bacterial, hydrophilic, self-cleaning, flame retardant finishes), Sun-screen dispersions for UV protection using titanium oxide – Colour cosmetics. Nanotechnology in Food Technology - Nanopackaging for enhanced shelf life - Smart/Intelligent packaging.

**TOTAL : 45 PERIODS**

**REFERENCES:**

1. Introduction to Nanocomposite Materials. Properties, Processing, Characterization-Thomas E. Twardowski. 2007. DEStech Publications. USA.
2. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V.Braun 2006.
3. Physical Properties of Carbon Nanotubes- R. Saito 1998.
4. Carbon Nanotubes (Carbon , Vol 33) - M. Endo, S. Iijima, M.S. Dresselhaus 1997.
5. The search for novel, superhard materials- Stan Veprjek (Review Article) JVST A, 1999
6. Nanometer versus micrometer-sized particles-Christian Brosseau, Jamal BeN Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) J. Appl. Phys, Vol 93, 2003
7. Diblock Copolymer, - Aviram (Review Article), Nature, 2002
8. Bikramjit Basu, Kantesh Balani Advanced Structural Ceramics, A John Wiley & Sons, Inc.,
9. P. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead publication, London, 2006

**BY4016 IPR, BIOSAFETY AND ENTREPRENEURSHIP L T P C  
 3 0 0 3**

**UNIT I IPR 9**  
 Intellectual property rights – Origin of the patent regime – Early patents act & Indian pharmaceutical industry – Types of patents – Patent Requirements – Application preparation filing and prosecution – Patentable subject matter – Industrial design, Protection of GMO's IP as a factor in R&D, IP's of relevance to biotechnology and few case studies.

**UNIT II AGREEMENTS, TREATIES AND PATENT FILING PROCEDURES 9**  
 History of GATT Agreement – Madrid Agreement – Hague Agreement – WIPO Treaties –

Budapest Treaty – PCT – Ordinary – PCT – Conventional – Divisional and Patent of Addition – Specifications – Provisional and complete – Forms and fees Invention in context of “prior art” – Patent databases – Searching International Databases – Country-wise patent searches (USPTO, espacenet(EPO) – PATENT Scope (WIPO) – IPO, etc National & PCT filing procedure – Time frame and cost – Status of the patent applications filed – Precautions while patenting – disclosure/non-disclosure – Financial assistance for patenting – Introduction to existing schemes Patent licensing and agreement Patent infringement – Meaning, scope, litigation, case studies

### **UNIT III BIOSAFETY**

**9**

Introduction – Historical Background – Introduction to Biological Safety Cabinets – Primary Containment for Biohazards – Biosafety Levels – Biosafety Levels of Specific Microorganisms – Recommended Biosafety Levels for Infectious Agents and Infected Animals – Biosafety guidelines – Government of India.

### **UNIT IV GENETICALLY MODIFIED ORGANISMS**

**9**

Definition of GMOs & LMOs – Roles of Institutional Biosafety Committee – RCGM – GEAC etc. for GMO applications in food and agriculture – Environmental release of GMOs – Risk Analysis – Risk Assessment – Risk management and communication – Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

### **UNIT V ENTREPRENEURSHIP DEVELOPMENT**

**9**

Introduction – Entrepreneurship Concept – Entrepreneurship as a career – Entrepreneurial personality – Characteristics of successful Entrepreneur – Factors affecting entrepreneurial growth – Entrepreneurial Motivation – Competencies – Mobility – Entrepreneurship Development Programmes (EDP) - Launching Of Small Enterprise - Definition, Characteristics – Relationship between small and large units – Opportunities for an Entrepreneurial career – Role of small enterprise in economic development – Problems of small scale industries – Institutional finance to entrepreneurs - Institutional support to entrepreneurs.

**TOTAL : 45 PERIODS**

### **REFERENCES**

1. Bouchoux, D.E., “Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets for the Paralegal”, 3rd Edition, Delmar Cengage Learning, 2008.
2. Fleming, D.O. and Hunt, D.L., “Biological Safety: Principles and Practices”, 4th Edition, American Society for Microbiology, 2006.
3. Irish, V., “Intellectual Property Rights for Engineers”, 2nd Edition, The Institution of Engineering and Technology, 2005.
4. Mueller, M.J., “Patent Law”, 3rd Edition, Wolters Kluwer Law & Business, 2009.
5. Young, T., “Genetically Modified Organisms and Biosafety: A Background Paper for Decision-Makers and Others to Assist in Consideration of GMO Issues” 1st Edition, World Conservation Union, 2004.
6. S.S Khanka, “Entrepreneurial Development”, S.Chand & Company LTD, New Delhi, 2007.

**ANNA UNIVERSITY, CHENNAI**  
**AFFILIATED INSTITUTIONS**  
**M.E.APPLIED ELECTRONICS**  
**REGULATIONS – 2017**  
**CHOICE BASED CREDIT SYSTEM**

**PROGRAM EDUCATIONAL OBJECTIVES (PEOs)**

1. To enable graduates to develop solutions to real world problems in the frontier areas of Applied Electronics.
2. To enable the graduates to adapt to the latest trends in technology through self-learning and to pursue research to meet out the demands in industries and Academia.
3. To enable the graduates to exhibit leadership skills and enhance their abilities through lifelong learning.

**PROGRAM OUTCOMES (POs)**

**Engineering Graduates will be able to:**

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.



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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.

### **PROGRAMME SPECIFIC OUTCOMES (PSOs)**

- PSO1:** To critically evaluate the design and provide optimal solutions to problem areas in advanced signal processing, digital system design, embedded systems and VLSI design.
- PSO2:** To enhance and develop electronic systems using modern engineering hardware and software tools.
- PSO3:** To work professionally and ethically in applied electronics and related areas.

### **Mapping of Programme Educational Objectives (PEOs) and the Program Outcomes (Pos):**

| PEOs | PROGRAM OUTCOMES (POS) |     |     |     |     |     |     |     |     |      |      |      |
|------|------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
|      | PO1                    | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| PEO1 | 3                      | 3   | 3   | 2   | 2   | 1   | 1   | -   | 2   | 3    | 2    | 2    |
| PEO2 | 3                      | 2   | 2   | 2   | 2   | -   | -   | 2   | 3   | 3    | 3    | 3    |
| PEO3 | 3                      | 2   | 2   | 2   | 2   | 1   | 1   | 3   | 2   | 3    | 2    | 3    |

### **Mapping of Programme Specific Outcomes (PSOs) and the Program Outcomes (Pos):**

| PSOs | PROGRAM OUTCOMES (POS) |     |     |     |     |     |     |     |     |      |      |      |
|------|------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
|      | PO1                    | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| PSO1 | 3                      | 3   | 3   | 2   | 2   | 1   | 1   | 1   | 2   | 3    | 2    | 2    |
| PSO2 | 3                      | 2   | 3   | 2   | 3   | -   | -   | 2   | 3   | 3    | 2    | 2    |
| PSO3 | 3                      | 2   | 2   | 2   | -   | 3   | 1   | 3   | 2   | 3    | 2    | 3    |

**M.E. APPLIED ELECTRONICS  
SEMESTER COURSE WISE PO MAPPING**

|                                  |                    | SUBJECTS                                       | PROGRAMME OUTCOMES |     |     |     |     |     |     |     |     |      |      |      |
|----------------------------------|--------------------|--|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
|                                  |                    |  | PO1                | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| <b>I<br/>Y<br/>E<br/>A<br/>R</b> | <b>SEMESTER I</b>  | Applied Mathematics for Electronics Engineers  | 3                  | 3   | 2   | 1   |     |     |     | 3   | 2   | 3    |      | 2    |
|                                  |                    | Advanced Digital System Design                 | 3                  | 2   | 2   | 2   | 1   |     |     | 3   | 2   | 3    |      | 2    |
|                                  |                    | Advanced Digital Signal Processing             | 3                  | 2   | 2   | 2   | 1   |     |     | 3   | 2   | 3    |      | 2    |
|                                  |                    | Embedded System Design                         | 3                  | 2   | 2   | 2   | 2   |     |     | 3   | 2   | 3    |      | 2    |
|                                  |                    | Sensors, Actuators and Interface Electronics   | 3                  | 2   | 2   | 1   |     |     |     | 3   | 2   | 3    |      | 2    |
|                                  |                    | <b>Professional Elective I</b>                 |                    |     |     |     |     |     |     |     |     |      |      |      |
|                                  |                    | Digital Control Engineering                    | 3                  | 2   | 2   | 1   |     |     |     | 3   | 2   | 3    |      | 2    |
|                                  |                    | Computer Architecture and Parallel Processing  | 3                  | 2   | 2   | 1   |     |     |     | 3   | 2   | 3    |      | 2    |
|                                  |                    | CAD for VLSI                                   | 3                  | 2   | 2   | 2   | 1   |     |     | 3   | 2   | 3    |      | 2    |
|                                  |                    | Electromagnetic Interference and Compatibility | 3                  | 2   | 2   | 1   |     |     |     | 3   | 2   | 3    |      | 2    |
|                                  |                    | Electronic System Design Lab I                 | 3                  | 2   | 2   | 2   | 2   |     |     | 3   | 3   | 3    |      | 2    |
|                                  | <b>SEMESTER II</b> | Soft Computing and Optimization Techniques     | 3                  | 2   | 2   | 2   | 1   |     |     | 3   | 2   | 3    |      | 2    |
|                                  |                    | ASIC and FPGA Design                           | 3                  | 2   | 2   | 2   |     |     |     | 3   | 2   | 3    |      | 2    |
|                                  |                    | Hardware – Software Co-design                  | 3                  | 2   | 2   | 2   |     |     |     | 3   | 2   | 3    |      | 2    |
|                                  |                    | Digital Image Processing                       | 3                  | 2   | 2   | 2   | 1   |     |     | 3   | 2   | 3    |      | 2    |
|                                  |                    | <b>Professional Elective - II</b>              |                    |     |     |     |     |     |     |     |     |      |      |      |
| VLSI Design Techniques           | 3                  | 2  | 2                  | 2   | 1   |     |     |     | 3   | 2   | 3   |      | 2    |      |

|                        |                          |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|------------------------|--------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|                        |                          | Nano Electronics  | 3 | 2 | 1 |   |   |   |   | 3 | 2 | 3 |   | 2 |   |
|                        |                          | Wireless Adhoc and Sensor Networks                          | 3 | 2 | 1 |   |   |   |   | 3 | 2 | 3 |   | 2 |   |
|                        |                          | High Performance Networks                                   | 3 | 2 | 1 |   |   |   |   | 3 | 2 | 3 |   | 2 |   |
|                        |                          | <b>Professional Elective - III</b>                          |   |   |   |   |   |   |   |   |   |   |   |   |   |
|                        |                          | DSP Architectures and Programming                           | 3 | 2 | 2 | 2 | 2 |   |   | 3 | 2 | 3 |   | 2 |   |
|                        |                          | RF System Design  | 3 | 2 | 2 | 1 |   |   |   | 3 | 2 | 3 |   | 2 |   |
|                        |                          | Speech and Audio Signal Processing                          | 3 | 2 | 2 | 1 | 1 |   |   | 3 | 2 | 3 |   | 2 |   |
|                        |                          | Solid State Device Modeling and Simulation                  | 3 | 2 | 2 | 1 |   |   |   | 3 | 2 | 3 |   | 2 |   |
|                        |                          | Electronic System Design Lab II                             | 3 | 2 | 2 | 2 | 2 |   |   | 3 | 3 | 3 |   | 2 |   |
|                        |                          | Term Paper Writing and Seminar                              | 3 | 2 | 2 | 1 |   |   |   | 3 | 3 | 3 |   | 3 |   |
| II<br>Y<br>E<br>A<br>R | SEMESTER III             | Advanced Microprocessors and Microcontrollers Architectures | 3 | 2 | 2 | 2 |   |   |   | 3 | 2 | 3 |   | 2 |   |
|                        |                          | <b>Professional Elective –IV</b>                            |   |   |   |   |   |   |   |   |   |   |   |   |   |
|                        |                          | Internet of Things  | 3 | 2 | 2 | 2 | 1 |   |   |   | 3 | 2 | 3 |   | 2 |
|                        |                          | System on Chip Design                                       | 3 | 2 | 2 | 1 | 1 |   |   |   | 3 | 2 | 3 |   | 2 |
|                        |                          | Robotics  | 3 | 2 | 2 | 2 | 1 |   |   |   | 3 | 2 | 3 |   | 2 |
|                        |                          | Physical Design of VLSI Circuits                            | 3 | 2 | 2 | 1 |   |   |   |   | 3 | 2 | 3 |   | 2 |
|                        |                          | <b>Professional Elective V</b>                              |   |   |   |   |   |   |   |   |   |   |   |   |   |
|                        |                          | Signal Integrity for High Speed Design                      | 3 | 2 | 1 |   |   |   |   |   | 3 | 2 | 3 |   | 2 |
|                        |                          | MEMS and NEMS   | 3 | 2 | 1 |   |   |   |   |   | 3 | 2 | 3 |   | 2 |
|                        | Secure Computing Systems | 3   | 2 | 2 | 1 |   |   |   |   | 3 | 2 | 3 |   | 2 |   |
|                        | Pattern Recognition      | 3   | 2 | 2 |   |   |   |   | 3 | 2 | 3 |   | 2 |   |   |
|                        | Project Work Phase I     | 3   | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 |   |   |
|                        | SEM IV                   | Project Work Phase – II                                     | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 |   |

**ANNA UNIVERSITY, CHENNAI**  
**AFFILIATED INSTITUTIONS**  
**M.E. APPLIED ELECTRONICS**  
**REGULATIONS – 2017**  
**CHOICE BASED CREDIT SYSTEM**  
**CURRICULA AND SYLLABI**

**SEMESTER I**

| SL. NO            | COURSE CODE | COURSE TITLE                                  | CATEGORY | CONTACT PERIODS | L         | T        | P        | C         |
|-------------------|-------------|---|----------|-----------------|-----------|----------|----------|-----------|
| <b>THEORY</b>     |             |   |          |                 |           |          |          |           |
| 1.                | MA5152      | Applied Mathematics for Electronics Engineers | FC       | 4               | 4         | 0        | 0        | 4         |
| 2.                | AP5151      | Advanced Digital System Design                | PC       | 3               | 3         | 0        | 0        | 3         |
| 3.                | AP5152      | Advanced Digital Signal Processing            | PC       | 5               | 3         | 2        | 0        | 4         |
| 4.                | AP5191      | Embedded System Design                        | PC       | 3               | 3         | 0        | 0        | 3         |
| 5.                | AP5101      | Sensors, Actuators and Interface Electronics  | PC       | 3               | 3         | 0        | 0        | 3         |
| 6.                |             | Professional Elective I                       | PC       | 3               | 3         | 0        | 0        | 3         |
| <b>PRACTICALS</b> |             |   |          |                 |           |          |          |           |
| 7.                | AP5111      | Electronic System Design Laboratory I         | PC       | 4               | 0         | 0        | 4        | 2         |
| <b>TOTAL</b>      |             |   |          | <b>25</b>       | <b>19</b> | <b>2</b> | <b>4</b> | <b>22</b> |

**SEMESTER II**

| SL. NO            | COURSE CODE | COURSE TITLE                               | CATEGORY | CONTACT PERIODS | L         | T        | P        | C         |
|-------------------|-------------|--|----------|-----------------|-----------|----------|----------|-----------|
| <b>THEORY</b>     |             |  |          |                 |           |          |          |           |
| 1.                | AP5251      | Soft Computing and Optimization Techniques | PC       | 3               | 3         | 0        | 0        | 3         |
| 2.                | AP5252      | ASIC and FPGA Design                       | PC       | 3               | 3         | 0        | 0        | 3         |
| 3.                | AP5291      | Hardware – Software Co-design              | PC       | 3               | 3         | 0        | 0        | 3         |
| 4.                | AP5292      | Digital Image Processing                   | PC       | 3               | 3         | 0        | 0        | 3         |
| 5.                |             | Professional Elective II                   | PE       | 3               | 3         | 0        | 0        | 3         |
| 6.                |             | Professional Elective III                  | PE       | 3               | 3         | 0        | 0        | 3         |
| <b>PRACTICALS</b> |             |  |          |                 |           |          |          |           |
| 7.                | AP5211      | Electronic System Design Laboratory II     | PC       | 4               | 0         | 0        | 4        | 2         |
| 8.                | CP5281      | Term Paper Writing and Seminar             | EEC      | 2               | 0         | 0        | 2        | 1         |
| <b>TOTAL</b>      |             |  |          | <b>24</b>       | <b>18</b> | <b>0</b> | <b>6</b> | <b>21</b> |

**SEMESTER III**

| SL. NO            | COURSE CODE | COURSE TITLE  | CATEGORY | CONTACT PERIODS | L        | T        | P         | C         |
|-------------------|-------------|---|----------|-----------------|----------|----------|-----------|-----------|
| <b>THEORY</b>     |             |   |          |                 |          |          |           |           |
| 1.                | AP5301      | Advanced Microprocessors and Microcontrollers Architectures | PC       | 3               | 3        | 0        | 0         | 3         |
| 2.                |             | Professional Elective IV                                    | PE       | 3               | 3        | 0        | 0         | 3         |
| 3.                |             | Professional Elective V                                     | PE       | 3               | 3        | 0        | 0         | 3         |
| <b>PRACTICALS</b> |             |   |          |                 |          |          |           |           |
| 4.                | AP5311      | Project Work Phase I  | EEC      | 12              | 0        | 0        | 12        | 6         |
| <b>TOTAL</b>      |             |   |          | <b>21</b>       | <b>9</b> | <b>0</b> | <b>12</b> | <b>15</b> |

**SEMESTER IV**

| SL. NO            | COURSE CODE | COURSE TITLE          | CATEGORY | CONTACT PERIODS | L        | T         | P         | C  |
|-------------------|-------------|-----------------------|----------|-----------------|----------|-----------|-----------|----|
| <b>PRACTICALS</b> |             |                       |          |                 |          |           |           |    |
| 1.                | AP5411      | Project Work Phase II | EEC      | 24              | 0        | 0         | 24        | 12 |
| <b>TOTAL</b>      |             |                       |          | <b>0</b>        | <b>0</b> | <b>24</b> | <b>12</b> |    |

**TOTAL NO. OF CREDITS: 70**

### FOUNDATION COURSES (FC)

| SL. NO | COURSE CODE | COURSE TITLE                                  | CATEGORY | CONTACT PERIODS | L | T | P | C |
|--------|-------------|---|----------|-----------------|---|---|---|---|
| 1.     | MA5152      | Applied Mathematics for Electronics Engineers | FC       | 4               | 4 | 0 | 0 | 4 |

### PROFESSIONAL CORE (PC)

| SL. NO | COURSE CODE | COURSE TITLE   | CATEGORY | CONTACT PERIODS | L | T | P | C |
|--------|-------------|--|----------|-----------------|---|---|---|---|
| 1.     | AP5151      | Advanced Digital System Design                           | PC       | 3               | 3 | 0 | 0 | 3 |
| 2.     | AP5152      | Advanced Digital Signal Processing                       | PC       | 5               | 3 | 2 | 0 | 4 |
| 3.     | AP5191      | Embedded System Design                                   | PC       | 3               | 3 | 0 | 0 | 3 |
| 4.     | AP5101      | Sensors, Actuators and Interface Electronics             | PC       | 3               | 3 | 0 | 0 | 3 |
| 5.     | AP5111      | Electronic System Design Lab I                           | PC       | 4               | 0 | 0 | 4 | 2 |
| 6.     | AP5251      | Soft Computing and Optimization Techniques               | PC       | 3               | 3 | 0 | 0 | 3 |
| 7.     | AP5252      | ASIC and FPGA Design                                     | PC       | 3               | 3 | 0 | 0 | 3 |
| 8.     | AP5291      | Hardware – Software Co-design                            | PC       | 3               | 3 | 0 | 0 | 3 |
| 9.     | AP5292      | Digital Image Processing                                 | PC       | 3               | 3 | 0 | 0 | 3 |
| 10.    | AP5211      | Electronic System Design Lab II                          | PC       | 4               | 0 | 0 | 4 | 2 |
| 11.    | AP5301      | Advanced Microprocessor and Microcontroller Architecture | PC       | 3               | 3 | 0 | 0 | 3 |

### EMPLOYABILITY ENHANCEMENT COURSE (EEC)

| SL. NO | COURSE CODE | COURSE TITLE                   | CATEGORY | CONTACT PERIODS | L | T | P  | C  |
|--------|-------------|--------------------------------|----------|-----------------|---|---|----|----|
| 1.     | CP5281      | Term Paper Writing and Seminar | EEC      | 2               | 0 | 0 | 2  | 1  |
| 2.     | AP5311      | Project Work Phase – I         | EEC      | 12              | 0 | 0 | 12 | 6  |
| 3.     | AP5411      | Project Work Phase – II        | EEC      | 24              | 0 | 0 | 24 | 12 |

**PROFESSIONAL ELECTIVES (PE)\*  
SEMESTER I  
ELECTIVE I**

| SL. NO | COURSE CODE | COURSE TITLE                                   | CATEGORY | CONTACT PERIODS | L | T | P | C |
|--------|-------------|--|----------|-----------------|---|---|---|---|
| 1.     | AP5091      | Digital Control Engineering                    | PE       | 3               | 3 | 0 | 0 | 3 |
| 2.     | AP5001      | Computer Architecture and Parallel Processing  | PE       | 3               | 3 | 0 | 0 | 3 |
| 3.     | AP5002      | CAD for VLSI Circuits                          | PE       | 3               | 3 | 0 | 0 | 3 |
| 4.     | CU5292      | Electromagnetic Interference and Compatibility | PE       | 3               | 3 | 0 | 0 | 3 |

**SEMESTER II  
ELECTIVE II**

| SL. NO | COURSE CODE | COURSE TITLE                       | CATEGORY | CONTACT PERIODS | L | T | P | C |
|--------|-------------|------------------------------------|----------|-----------------|---|---|---|---|
| 1.     | AP5003      | VLSI Design Techniques             | PE       | 3               | 3 | 0 | 0 | 3 |
| 2.     | AP5071      | Nano Electronics                   | PE       | 3               | 3 | 0 | 0 | 3 |
| 3.     | CU5097      | Wireless Adhoc and Sensor Networks | PE       | 3               | 3 | 0 | 0 | 3 |
| 4.     | AP5004      | High Performance Networks          | PE       | 3               | 3 | 0 | 0 | 3 |

**SEMESTER II  
ELECTIVE III**

| SL. NO | COURSE CODE | COURSE TITLE                               | CATEGORY | CONTACT PERIODS | L | T | P | C |
|--------|-------------|--|----------|-----------------|---|---|---|---|
| 1.     | DS5191      | DSP Processor Architecture and Programming | PE       | 3               | 3 | 0 | 0 | 3 |
| 2.     | AP5073      | RF System Design                           | PE       | 3               | 3 | 0 | 0 | 3 |
| 3.     | AP5074      | Speech and Audio Signal Processing         | PE       | 3               | 3 | 0 | 0 | 3 |
| 4.     | AP5092      | Solid State Device Modeling and Simulation | PE       | 3               | 3 | 0 | 0 | 3 |

**SEMESTER III  
ELECTIVE IV**

| <b>SL. NO</b> | <b>COURSE CODE</b> | <b>COURSE TITLE</b>              | <b>CATEGORY</b> | <b>CONTACT PERIODS</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|---------------|--------------------|----------------------------------|-----------------|------------------------|----------|----------|----------|----------|
| 1.            | CP5292             | Internet of Things               | PE              | 3                      | 3        | 0        | 0        | 3        |
| 2.            | AP5005             | System on Chip Design            | PE              | 3                      | 3        | 0        | 0        | 3        |
| 3.            | AP5093             | Robotics                         | PE              | 3                      | 3        | 0        | 0        | 3        |
| 4.            | AP5006             | Physical Design of VLSI Circuits | PE              | 3                      | 3        | 0        | 0        | 3        |

**SEMESTER III  
ELECTIVE V**

| <b>SL. NO</b> | <b>COURSE CODE</b> | <b>COURSE TITLE</b>                    | <b>CATEGORY</b> | <b>CONTACT PERIODS</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|---------------|--------------------|--|-----------------|------------------------|----------|----------|----------|----------|
| 1.            | AP5094             | Signal Integrity for High Speed Design | PE              | 3                      | 3        | 0        | 0        | 3        |
| 2.            | VL5091             | MEMS and NEMS                          | PE              | 3                      | 3        | 0        | 0        | 3        |
| 3.            | AP5007             | Secure Computing Systems               | PE              | 3                      | 3        | 0        | 0        | 3        |
| 4.            | AP5008             | Pattern Recognition                    | PE              | 3                      | 3        | 0        | 0        | 3        |

**OBJECTIVES:**

The main objective of this course is to demonstrate various analytical skills in applied mathematics and extensive experience with the tactics of problem solving and logical thinking applicable in electronics engineering. This course also will help the students to identify, formulate, abstract, and solve problems in electrical engineering using mathematical tools from a variety of mathematical areas, including fuzzy logic, matrix theory, probability, dynamic programming and queuing theory.

**UNIT I FUZZY LOGIC****12**

Classical logic – Multivalued logics – Fuzzy propositions – Fuzzy quantifiers.

**UNIT II MATRIX THEORY****12**

Cholesky decomposition - Generalized Eigenvectors - Canonical basis - QR factorization - Least squares method - Singular value decomposition.

**UNIT III PROBABILITY AND RANDOM VARIABLES****12**

Probability – Axioms of probability – Conditional probability – Baye’s theorem - Random variables - Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a Random variable.

**UNIT IV DYNAMIC PROGRAMMING****12**

Dynamic programming – Principle of optimality – Forward and backward recursion – Applications of dynamic programming – Problem of dimensionality.

**UNIT V QUEUEING MODELS****12**

Poisson Process – Markovian queues – Single and multi server models – Little’s formula - Machine interference model – Steady state analysis – Self service queue.

**TOTAL: 60 PERIODS****OUTCOMES:**

**After completing this course, students should demonstrate competency in the following skills:**

- Concepts of fuzzy sets, knowledge representation using fuzzy rules, fuzzy logic, fuzzy prepositions and fuzzy quantifiers and applications of fuzzy logic.
- Apply various methods in matrix theory to solve system of linear equations.
- Computation of probability and moments, standard distributions of discrete and continuous random variables and functions of a random variable.
- Conceptualize the principle of optimality and sub-optimization, formulation and computational procedure of dynamic programming
- Exposing the basic characteristic features of a queuing system and acquire skills in analyzing queuing models.
- Using discrete time Markov chains to model computer systems.

**REFERENCES:**

1. Bronson, R., "Matrix Operations", Schaum's Outline Series, McGraw Hill, 2011.
2. George, J. Klir. and Yuan, B., "Fuzzy sets and Fuzzy logic, Theory and Applications", Prentice Hall of India Pvt. Ltd., 1997.
3. Gross, D., Shortle J. F., Thompson, J.M., and Harris, C. M., "Fundamentals of Queueing Theory", 4<sup>th</sup> Edition, John Wiley, 2014.
4. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8<sup>th</sup> Edition, 2015.
5. Taha, H.A., "Operations Research: An Introduction", 9<sup>th</sup> Edition, Pearson Education, Asia, New Delhi, 2016.

**OBJECTIVES:**

- To introduce methods to analyze and design synchronous and asynchronous sequential circuits.
- To introduce the architectures of programmable devices.
- To introduce design and implementation of digital circuits using programming tools.

**UNIT I SEQUENTIAL CIRCUIT DESIGN****9**

Analysis of clocked synchronous sequential circuits and modeling- State diagram, state table, state table assignment and reduction-Design of synchronous sequential circuits design of iterative circuits-ASM chart and realization using ASM

**UNIT II ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN****9**

Analysis of asynchronous sequential circuit – flow table reduction-races-state assignment-transition table and problems in transition table- design of asynchronous sequential circuit-Static, dynamic and essential hazards – data synchronizers – mixed operating mode asynchronous circuits – designing vending machine controller

**UNIT III FAULT DIAGNOSIS AND TESTABILITY ALGORITHMS****9**

Fault table method-path sensitization method – Boolean difference method-D algorithm - Tolerance techniques – The compact algorithm – Fault in PLA – Test generation-DFT schemes – Built in self test

**UNIT IV SYNCHRONOUS DESIGN USING PROGRAMMABLE DEVICES****9**

Programming logic device families – Designing a synchronous sequential circuit using PLA/PAL – Realization of finite state machine using PLD – FPGA – Xilinx FPGA-Xilinx 4000

**UNIT V SYSTEM DESIGN USING VERILOG****9**

Hardware Modelling with Verilog HDL – Logic System, Data Types and Operators For Modelling in Verilog HDL - Behavioural Descriptions in Verilog HDL – HDL Based Synthesis – Synthesis of Finite State Machines– structural modeling – compilation and simulation of Verilog code –Test bench - Realization of combinational and sequential circuits using Verilog – Registers – counters – sequential machine – serial adder – Multiplier- Divider – Design of simple microprocessor.

**TOTAL : 45 PERIODS****OUTCOMES:**

**At the end of the course, the student should be able to:**

- Analyze and design sequential digital circuits
- Identify the requirements and specifications of the system required for a given application
- Design and use programming tools for implementing digital circuits of industry standards

**REFERENCES:**

1. Charles H.Roth Jr “Fundamentals of Logic Design” Thomson Learning 2004
2. M.D.Ciletti , Modeling, Synthesis and Rapid Prototyping with the Verilog HDL, Prentice Hall, 1999.
3. M.G.Arnold, Verilog Digital – Computer Design, Prentice Hall (PTR), 1999.
4. Nripendra N Biswas “Logic Design Theory” Prentice Hall of India,2001
5. Parag K.Lala “Digital system Design using PLD” B S Publications,2003
6. Parag K.Lala “Fault Tolerant and Fault Testable Hardware Design” B S Publications,2002
7. S. Palnitkar , Verilog HDL – A Guide to Digital Design and Synthesis, Pearson , 2003.

**OBJECTIVES:**

- The student comprehends mathematical description and modelling of discrete time random signals.
- The student is conversant with important theorems and random signal processing algorithms.
- The student learns relevant figures of merit such as power, energy, bias and consistency.
- The student is familiar with estimation, prediction, filtering, multirate concepts and techniques.

**UNIT I DISCRETE RANDOM SIGNAL PROCESSING 9+6**

Discrete random processes – Ensemble averages – Wide sense stationary process – Properties - Ergodic process – Sample mean & variance - Auto-correlation and Auto-correlation matrices- Properties – White noise process – Weiner Khitchine relation - Power spectral density – Filtering random process – Spectral Factorization Theorem – Special types of Random Processes – AR,MA, ARMA Processes – Yule-Walker equations.

**UNIT II SPECTRUM ESTIMATION 9+6**

Bias and Consistency of estimators - Non-Parametric methods – Periodogram – Modified Periodogram – Barlett's method – Welch's method – Blackman-Tukey method – Parametric methods – AR, MA and ARMA spectrum estimation - Performance analysis of estimators.

**UNIT III SIGNAL MODELING AND OPTIMUM FILTERS 9+6**

Introduction- Least square method – Pade approximation – Prony's method – Levinson Recursion – Lattice filter - FIR Wiener filter – Filtering – Linear Prediction – Non Causal and Causal IIR Wiener Filter -- Mean square error – Discrete Kalman filter.

**UNIT IV ADAPTIVE FILTERS 9+6**

FIR Adaptive filters - Newton's steepest descent method – Widrow Hoff LMS Adaptive algorithm – Convergence – Normalized LMS – Applications – Noise cancellation - channel equalization – echo canceller – Adaptive Recursive Filters - RLS adaptive algorithm – Exponentially weighted RLS-sliding window RLS.

**UNIT V MULTIRATE SIGNAL PROCESSING 9+6**

Decimation - Interpolation – Sampling Rate conversion by a rational factor I/D – Multistage implementation of sampling rate conversion – Polyphase filter structures – Applications of multirate signal processing.

**TOTAL45+30: 75 PERIODS****OUTCOMES:**

- Formulate time domain and frequency domain description of Wide Sense Stationary process in terms of matrix algebra and relate to linear algebra concepts.
- State W-K theorem, spectral factorization theorem, spectrum estimation, bias and consistency of estimators.
- Wiener filtering, LMS algorithms, Levinson recursion algorithm, applications of adaptive filters
- Decimation, interpolation, Sampling rate conversion, Applications of multirate signal processing

## REFERENCES:

1. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing", Prentice Hall of India, New Delhi, 2005.
2. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons Inc., New York, 2006.
3. P. P. Vaidyanathan, "Multirate Systems and Filter Banks", Prentice Hall, 1992.
4. S. Kay, "Modern spectrum Estimation theory and application", Prentice Hall, Englewood Cliffs, NJ1988.
5. Simon Haykin, "Adaptive Filter Theory", Prentice Hall, Englewood Cliffs, NJ1986.
6. Sophoncles J. Orfanidis, "Optimum Signal Processing", McGraw-Hill, 2000.

AP5191

EMBEDDED SYSTEM DESIGN

L T P C  
3 0 0 3

## OBJECTIVES:

The students should be made to:

- Learn design challenges and design methodologies
- Study general and single purpose processor
- Understand bus structures

### UNIT I EMBEDDED SYSTEM OVERVIEW 9

Embedded System Overview, Design Challenges – Optimizing Design Metrics, Design Methodology, RT-Level Combinational and Sequential Components, Optimizing Custom Single-Purpose Processors.

### UNIT II GENERAL AND SINGLE PURPOSE PROCESSOR 9

Basic Architecture, Pipelining, Superscalar and VLIW architectures, Programmer's view, Development Environment, Application-Specific Instruction-Set Processors (ASIPs) Microcontrollers, Timers, Counters and watchdog Timer, UART, LCD Controllers and Analog-to-Digital Converters, Memory Concepts.

### UNIT III BUS STRUCTURES 9

Basic Protocol Concepts, Microprocessor Interfacing – I/O Addressing, Port and Bus-Based I/O, Arbitration, Serial Protocols, I<sup>2</sup>C, CAN and USB, Parallel Protocols – PCI and ARM Bus, Wireless Protocols – IrDA, Bluetooth, IEEE 802.11.

### UNIT IV STATE MACHINE AND CONCURRENT PROCESS MODELS 9

Basic State Machine Model, Finite-State Machine with Datapath Model, Capturing State Machine in Sequential Programming Language, Program-State Machine Model, Concurrent Process Model, Communication among Processes, Synchronization among processes, Dataflow Model, Real-time Systems, Automation: Synthesis, Verification : Hardware/Software Co-Simulation, Reuse: Intellectual Property Cores, Design Process Models.

### UNIT V EMBEDDED SOFTWARE DEVELOPMENT TOOLS AND RTOS 9

Compilation Process – Libraries – Porting kernels – C extensions for embedded systems – emulation and debugging techniques – RTOS – System design using RTOS.

**OUTCOMES:**

**At the end of this course, the students should be able to:**

- Explain different protocols
- Discuss state machine and design process models
- Outline embedded software development tools and RTOS

**REFERENCES:**

1. Bruce Powel Douglas, "Real time UML, second edition: Developing efficient objects for embedded systems", 3rd Edition 1999, Pearson Education.
2. Daniel W. Lewis, "Fundamentals of embedded software where C and assembly meet", Pearson Education, 2002.
3. Frank Vahid and Tony Gwargie, "Embedded System Design", John Wiley & sons, 2002.
4. Steve Heath, "Embedded System Design", Elsevier, Second Edition, 2004.

**AP5101**

**SENSORS, ACTUATORS AND INTERFACE ELECTRONICS**

**L T P C  
3 0 0 3**

**OBJECTIVES:**

- Understand static and dynamic characteristics of measurement systems.
- Study various types of sensors.
- Study different types of actuators and their usage.
- Study State-of-the-art digital and semiconductor sensors.

**UNIT I INTRODUCTION TO MEASUREMENT SYSTEMS**

**9**

Introduction to measurement systems: general concepts and terminology, measurement systems, sensor classification, general input-output configuration, methods of correction, performance characteristics: static characteristics of measurement systems, accuracy, precision, sensitivity, other characteristics: linearity, resolution, systematic errors, random errors, dynamic characteristics of measurement systems: zero-order, first-order, and second-order measurement systems and response.

**UNIT II RESISTIVE AND REACTIVE SENSORS**

**9**

Resistive sensors: potentiometers, strain gages, resistive temperature detectors, magneto resistors, light-dependent resistors, Signal conditioning for resistive sensors: Wheatstone bridge, sensor bridge calibration and compensation, Instrumentation amplifiers, sources of interference and interference reduction, Reactance variation and electromagnetic sensors, capacitive sensors, differential, inductive sensors, linear variable differential transformers (LVDT), magneto elastic sensors, hall effect sensors, Signal conditioning for reactance-based sensors & application to the LVDT.

**UNIT III SELF-GENERATING SENSORS**

**9**

Self-generating sensors: thermoelectric sensors, piezoelectric sensors, pyroelectric sensors, photovoltaic sensors, electrochemical sensors, Signal conditioning for self-generating sensors: chopper and low-drift amplifiers, offset and drifts amplifiers, electrometer amplifiers, charge amplifiers, noise in amplifiers.

**UNIT IV ACTUATORS DRIVE CHARACTERISTICS AND APPLICATIONS**

**9**





**TOTAL :45 PERIODS**

**OUTCOMES:****Upon Completion of the course, the students will be able to:**

- Implement machine learning through Neural networks.
- Develop a Fuzzy expert system.
- Model Neuro Fuzzy system for clustering and classification.
- Able to use the optimization techniques to solve the real world problems

**REFERENCES :**

1. David E. Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Addison wesley, 2009.
2. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic-Theory and Applications, Prentice Hall, 1995.
3. James A. Freeman and David M. Skapura, Neural Networks Algorithms, Applications, and Programming Techniques, Pearson Edn., 2003.
4. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, Neuro-Fuzzy and Soft Computing, Prentice-Hall of India, 2003.
5. Mitchell Melanie, An Introduction to Genetic Algorithm, Prentice Hall, 1998.
6. Simon Haykins, Neural Networks: A Comprehensive Foundation, Prentice Hall International Inc, 1999.
7. Singiresu S. Rao, Engineering optimization Theory and practice, John Wiley & sons, inc, Fourth Edition, 2009
8. Timothy J. Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, 1997.
9. Venkata Rao, Vimal J. Savsani, Mechanical Design Optimization Using Advanced Optimization Techniques, springer 2012

**AP5252****ASIC AND FPGA DESIGN****L T P C  
3 0 0 3****OBJECTIVES:**

- To study the design flow of different types of ASIC.
- To familiarize the different types of programming technologies and logic devices.
- To learn the architecture of different types of FPGA.
- To gain knowledge about partitioning, floor planning, placement and routing including circuit extraction of ASIC

**UNIT I OVERVIEW OF ASIC AND PLD****9**

Types of ASICs - Design flow – CAD tools used in ASIC Design – Programming Technologies: Antifuse – static RAM – EPROM and EEPROM technology, Programmable Logic Devices: ROMs and EPROMs – PLA –PAL. Gate Arrays – CPLDs and FPGAs

**UNIT II ASIC PHYSICAL DESIGN****9**

System partition -partitioning - partitioning methods – interconnect delay models and measurement of delay - floor planning - placement – Routing: global routing - detailed routing - special routing - circuit extraction - DRC

**UNIT III LOGIC SYNTHESIS, SIMULATION AND TESTING****9**

Design systems - Logic Synthesis - Half gate ASIC -Schematic entry - Low level design language - PLA tools -EDIF- CFI design representation. Verilog and logic synthesis -VHDL and logic synthesis - types of simulation -boundary scan test - fault simulation - automatic test pattern generation.

**UNIT IV FIELD PROGRAMMABLE GATE ARRAYS****9**

FPGA Design : FPGA Physical Design Tools -Technology mapping - Placement & routing - Register transfer (RT)/Logic Synthesis - Controller/Data path synthesis - Logic minimization.

**UNIT V SOC DESIGN****9**

System-On-Chip Design - SoC Design Flow, Platform-based and IP based SoC Designs, Basic Concepts of Bus-Based Communication Architectures. High performance algorithms for ASICs/ SoCs as case studies: Canonical Signed Digit Arithmetic, Knowledge Crunching Machine, Distributed Arithmetic, High performance digital filters for sigma-delta ADC.

**TOTAL: 45 PERIODS****OUTCOMES:**

- To analyze the synthesis, Simulation and testing of systems.
- To apply different high performance algorithms in ASICs.
- To discuss the design issues of SOC.

**REFERENCES:**

1. David A.Hodges, Analysis and Design of Digital Integrated Circuits (3/e), MGH 2004
2. H.Gerez, Algorithms for VLSI Design Automation, John Wiley, 1999
3. Jan. M. Rabaey et al, Digital Integrated Circuit Design Perspective (2/e), PHI 2003
4. M.J.S. Smith : Application Specific Integrated Circuits, Pearson, 2003
5. J. Old Field, R.Dorf, Field Programmable Gate Arrays, John Wiley& Sons, Newyork.
6. P.K.Chan& S. Mourad, Digital Design using Field Programmable Gate Array, Prentice Hall.
7. Sudeep Pasricha and NikilDutt, On-Chip Communication Architectures System on Chip Interconnect, Elsevier, 2008
8. S.Trimberger, Edr., Field Programmable Gate Array Technology, Kluwer Academic Pub.
9. S.Brown,R.Francis, J.Rose, Z.Vransic, Field Programmable GateArray, Kluwer Pub. 5. Richard FJinder , "Engineering Digital Design,"Academic press

**AP5291****HARDWARE - SOFTWARE CO-DESIGN****L T P C  
3 0 0 3****OBJECTIVES:**

- To acquire the knowledge about system specification and modelling.
- To learn the formulation of partitioning
- To study the different technical aspects about prototyping and emulation.

**UNIT I SYSTEM SPECIFICATION AND MODELLING****9**

Embedded Systems, Hardware/Software Co-Design, Co-Design for System Specification and Modeling , Co-Design for Heterogeneous Implementation - Single-Processor Architectures with one ASIC and many ASICs, Multi-Processor Architectures, Comparison of Co- Design Approaches, Models of Computation, Requirements for Embedded System Specification.

**UNIT II HARDWARE / SOFTWARE PARTITIONING****9**

The Hardware/Software Partitioning Problem, Hardware-Software Cost Estimation, Generation of the Partitioning Graph, Formulation of the HW/SW Partitioning Problem, Optimization , HW/SW Partitioning based on Heuristic Scheduling, HW/SW Partitioning based on Genetic Algorithms .

**UNIT III HARDWARE / SOFTWARE CO-SYNTHESIS****9**

The Co-Synthesis Problem, State-Transition Graph, Refinement and Controller Generation, Co-Synthesis Algorithm for Distributed System- Case Studies with any one application.



**UNIT III      SEGMENTATION OF GRAY LEVEL IMAGES      9**

Histogram of gray level images, multilevel thresholding, Optimal thresholding using Bayesian classification, Watershed and Dam Construction algorithms for segmenting gray level image. Detection of edges and lines: First order and second order edge operators, multi-scale edge detection, Canny's edge detection algorithm, Hough transform for detecting lines and curves, edge linking.

**UNIT IV      IMAGE ENHANCEMENT AND COLOR IMAGE PROCESSING      9**

Point processing, Spatial Filtering, Frequency domain filtering, multi-spectral image enhancement, image restoration. Color Representation, Laws of color matching, chromaticity diagram, color enhancement, color image segmentation, color edge detection, color demosaicing.

**UNIT V      IMAGE COMPRESSION      9**

Lossy and lossless compression schemes, prediction based compression schemes, vector quantization, sub-band encoding schemes, JPEG compression standard, Fractal compression scheme, Wavelet compression scheme.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

**At the end of this course, the students should be able to:**

- Discuss image enhancement techniques
- Explain color image processing
- Compare image compression schemes

**REFERENCES:**

1. A.K. Jain, "Fundamentals of Digital Image Processing", Prentice-Hall, Addison-Wesley, 1989.
2. B. Jähne, "Practical Handbook on Image Processing for Scientific Applications", CRC Press, 1997.
3. Bernd Jähne, Digital Image Processing, Springer-Verlag Berlin Heidelberg 2005.
4. Bovik (ed.), "Handbook of Image and Video Processing", Academic Press, 2000.
5. Gonzalez and Woods, Digital Image Processing, Prentice-Hall.
6. J. C. Russ. The Image Processing Handbook. CRC, Boca Raton, FL, 4th edn., 2002.
7. J. S. Lim, "Two-dimensional Signal and Image Processing" Prentice-Hall, 1990.
8. M. Petrou, P. Bosdogianni, "Image Processing, The Fundamentals", Wiley, 1999.
9. Rudra Pratap, Getting Started With MATLAB 7. Oxford University Press, 2006
10. Stephane Marchand-Maillet, Yazid M. Sharaiha, Binary Digital Image Processing, A Discrete Approach, Academic Press, 2000.
11. W. K. Pratt. Digital image processing, PIKS Inside. Wiley, New York, 3rd, edn., 2001.

**AP5211**

**ELECTRONICS SYSTEM DESIGN LABORATORY II**

**L T P C  
0 0 4 2**

**OBJECTIVES:**

- To study of 32 bit ARM7 microcontroller RTOS and its application
- To understand testing RTOS environment and system programming
- To learn wireless network design using embedded systems
- To learn System design using ASIC
- To know use of Verilog and VHDL in sequential digital system modeling

1. Study of 32 bit ARM7 microcontroller RTOS and its application
2. Testing RTOS environment and system programming
3. Designing of wireless network using embedded systems
4. Implementation of ARM with FPGA
5. Design and Implementation of ALU in FPGA using VHDL and Verilog
6. Modeling of Sequential Digital system using Verilog and VHDL
7. Flash controller programming - data flash with erase, verify and fusing
8. System design using ASIC
9. Design, simulation and analysis of signal integrity

**TOTAL: 60 PERIODS**

**OUTCOMES:**

**At the end of this course, the students should be able to:**

- Utilize ARM with FPGA
- Demonstrate design of ALU in FPGA using VHDL and Verilog
- Assess flash controller programming - data flash with erase, verify and fusing
- Explain design, simulation and analysis of signal integrity

**CP5281**

**TERM PAPER WRITING AND SEMINAR**

**L T P C  
0 0 2 1**

In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas. The work involves the following steps:

1. Selecting a subject, narrowing the subject into a topic
2. Stating an objective.
3. Collecting the relevant bibliography (atleast 15 journal papers)
4. Preparing a working outline.
5. Studying the papers and understanding the authors contributions and critically analysing each paper.
6. Preparing a working outline
7. Linking the papers and preparing a draft of the paper.
8. Preparing conclusions based on the reading of all the papers.
9. Writing the Final Paper and giving final Presentation

Please keep a file where the work carried out by you is maintained.

Activities to be carried Out

| <b>Activity</b>                         | <b>Instructions</b>   | <b>Submission week</b> | <b>Evaluation</b>   |
|---|---|------------------------|---|
| Selection of area of interest and Topic | You are requested to select an area of interest, topic and state an objective | 2 <sup>nd</sup> week   | <b>3 %</b><br>Based on clarity of thought, current relevance and clarity in writing |
| Stating an Objective                    |   |                        |   |

|  |   |                      |   |
|--|---|----------------------|---|
| Collecting Information about your area & topic   | <ol style="list-style-type: none"> <li>1. List 1 Special Interest Groups or professional society</li> <li>2. List 2 journals</li> <li>3. List 2 conferences, symposia or workshops</li> <li>4. List 1 thesis title</li> <li>5. List 3 web presences (mailing lists, forums, news sites)</li> <li>6. List 3 authors who publish regularly in your area</li> <li>7. Attach a call for papers (CFP) from your area.</li> </ol>   | 3 <sup>rd</sup> week | <b>3%</b><br>( the selected information must be area specific and of international and national standard)                                     |
| Collection of Journal papers in the topic in the context of the objective – collect 20 & then filter | <ul style="list-style-type: none"> <li>• You have to provide a complete list of references you will be using- Based on your objective -Search various digital libraries and Google Scholar</li> <li>• When picking papers to read - try to: <ul style="list-style-type: none"> <li>• Pick papers that are related to each other in some ways and/or that are in the same field so that you can write a meaningful survey out of them,</li> <li>• Favour papers from well-known journals and conferences,</li> <li>• Favour “first” or “foundational” papers in the field (as indicated in other people’s survey paper),</li> <li>• Favour more recent papers,</li> <li>• Pick a recent survey of the field so you can quickly gain an overview,</li> <li>• Find relationships with respect to each other and to your topic area (classification scheme/categorization)</li> <li>• Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered.</li> </ul> </li> </ul> | 4 <sup>th</sup> week | <b>6%</b> ( the list of standard papers and reason for selection)   |
| Reading and notes for first 5 papers   | <p>Reading Paper Process</p> <ul style="list-style-type: none"> <li>• For each paper form a Table answering the following questions:</li> <li>• What is the main topic of the article?</li> <li>• What was/were the main issue(s) the author said they want to discuss?</li> <li>• Why did the author claim it was important?</li> <li>• How does the work build on other’s work, in the author’s opinion?</li> <li>• What simplifying assumptions does the author claim to be making?</li> <li>• What did the author do?</li> <li>• How did the author claim they were going to evaluate their work and</li> </ul>   | 5 <sup>th</sup> week | <b>8%</b> ( the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper) |

|                                      |  |  |   |
|--------------------------------------|--|--|---|
|                                      | <p>compare it to others?</p> <ul style="list-style-type: none"> <li>• What did the author say were the limitations of their research?</li> <li>• What did the author say were the important directions for future research?</li> </ul> <p>Conclude with limitations/issues not addressed by the paper ( from the perspective of your survey)</p> |  |   |
| Reading and notes for next 5 papers  | Repeat Reading Paper Process   | 6 <sup>th</sup> week                     | <b>8%</b> ( the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper) |
| Reading and notes for final 5 papers | Repeat Reading Paper Process   | 7 <sup>th</sup> week                     | <b>8%</b> ( the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper) |
| Draft outline 1 and Linking papers   | Prepare a draft Outline, your survey goals, along with a classification / categorization diagram   | 8 <sup>th</sup> week                     | <b>8%</b> ( this component will be evaluated based on the linking and classification among the papers)  |
| Abstract                             | Prepare a draft abstract and give a presentation   | 9 <sup>th</sup> week                     | <b>6%</b><br>(Clarity, purpose and conclusion)<br><b>6%</b> Presentation & Viva Voce  |
| Introduction Background              | Write an introduction and background sections  | 10 <sup>th</sup> week                    | <b>5%</b> ( clarity)  |
| Sections of the paper                | Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey   | 11 <sup>th</sup> week                    | <b>10%</b> (this component will be evaluated based on the linking and classification among the papers)  |
| Your conclusions                     | Write your conclusions and future work   | 12 <sup>th</sup> week                    | <b>5%</b> ( conclusions – clarity and your ideas)   |
| Final Draft                          | Complete the final draft of your paper   | 13 <sup>th</sup> week                    | <b>10%</b> (formatting, English, Clarity and linking)<br><b>4%</b> Plagiarism Check Report  |
| Seminar                              | A brief 15 slides on your paper  | 14 <sup>th</sup> & 15 <sup>th</sup> week | <b>10%</b> (based on presentation and Viva-voce)  |

**TOTAL : 30 PERIODS**

**AP5301**

**ADVANCED MICROPROCESSORS AND  
MICROCONTROLLERS ARCHITECTURES**

**L T P C  
3 0 0 3**

**OBJECTIVES:**

- To familiarize about the features, specification and features of modern microprocessors.
- To gain knowledge about the architecture of Intel 32 and 64 bit microprocessors and salient features associated with them.
- To familiarize about the features, specification and features of modern microcontrollers.
- To gain knowledge about the 32 bit microcontrollers based on ARM and PIC32 architectures

**UNIT I FEATURES OF MODERN MICROPROCESSORS 9**

Evolution of microprocessors - Data and Address buses – clock speed – memory interface - multi-core architectures – cache memory hierarchy – operating modes – super scalar execution – dynamic execution – over clocking – integrated graphics processing - performance benchmarks.

**UNIT I HIGH PERFORMANCE CISC ARCHITECTURES 9**

Introduction to IA 32 bit architecture – Intel Pentium Processors family tree – Memory Management – Branch prediction logic - Superscalar architecture – Hyper threading technology – 64 bit extension technology – Intel 64 bit architecture - Intel Core processor family tree – Turbo boost technology – Smart cache - features of Nehalem microarchitecture

**UNIT II HIGH PERFORMANCE RISC ARCHITECTURE - ARM 9**

RISC architecture merits and demerits – The programmer's model of ARM Architecture – 3-stage pipeline ARM organization - 3-stage pipeline ARM organization – ARM instruction execution – Salient features of ARM instruction set - ARM architecture profiles (A, R and M profiles)

**UNIT III FEATURES OF MODERN MICROPROCESSORS 9**

Introduction to microcontrollers – microcontroller vs microprocessors – microcontroller architecture - Processor Core – Memory interfaces– Communication interfaces (SPI,I<sup>2</sup>C, USB and CAN) – ADC - PWM – Watchdog timers – Interrupts – Debugging interfaces

**UNIT IV HIGH PERFORMANCE MICROCONTROLLER ARCHITECTURES 9**

Introduction to the Cortex-M Processor Family - ARM 'Cortex-M3' architecture for microcontrollers – Thumb 2 instruction technology – Internal Registers - Nested Vectored Interrupt controller - Memory map - Interrupts and exception handling – Applications of Cotex-M3 architecture

**TOTAL : 45 PERIODS**

**OUTCOMES:**

**After completion of the course, the students should be able**

- To explain the features and important specifications of modern microprocessors
- To explain the salient features CISC microprocessors based on IA-32 bit and IA-64 bit architectures
- To explain the salient features RISC processors based on ARM architecture and different application profiles of ARM core
- To explain the features and important specifications of modern microcontrollers
- To explain about ARM – M3 architecture and its salient features

## REFERENCES:

1. Barry. B. Breg, "The Intel Microprocessors", PHI, 2008.
2. Gene .H. Miller . " Micro Computer Engineering , " Pearson Education , 2003.
3. Intel Inc, "Intel 64 and IA-32 Architectures Developer's Manual", Volume-I, 2016
4. Joseph Yiu, "The Definitive Guide to the ARM ® Cortex-M3", Newnes, 2010.
5. Scott Mueller, "Upgrading and Repairing PCs", 20<sup>th</sup> edition, Que.
6. Steve Furber, " ARM System –On –Chip architecture " Addison Wesley , 2000.
7. Trevor Martin, "The Designer's Guide to the Cortex-M Processor Family", Newnes, 2013.

AP5091

DIGITAL CONTROL ENGINEERING

L T P C  
3 0 0 3

## OBJECTIVES:

- The student learns the principles of PI, PD, PID controllers.
- The student analyses time and frequency response discrete time control system.
- The student is familiar with digital control algorithms.
- The student has the knowledge to implement PID control algorithms.

### UNIT I CONTROLLERS IN FEEDBACK SYSTEMS 9

Review of frequency and time response analysis and specifications of first order and second order feedback control systems, need for controllers, continuous time compensations, continuous time PI, PD, PID controllers, digital PID controllers.

### UNIT II BASIC DIGITAL SIGNAL PROCESSING IN CONTROL SYSTEMS 9

Sampling theorem, quantization, aliasing and quantization error, hold operation, mathematical model of sample and hold, zero and first order hold, factors limiting the choice of sampling rate, reconstruction.

### UNIT III MODELING OF SAMPLED DATA CONTROL SYSTEM 9

Difference equation description, Z-transform method of description, pulse transfer function, time and frequency response of discrete time control systems, stability of digital control systems, Jury's stability test, state space description, first companion, second companion, Jordan canonical models, discrete state variable models (elementary principles only).

### UNIT IV DESIGN OF DIGITAL CONTROL ALGORITHMS 9

Review of principle of compensator design, Z-plane specifications, digital compensator design using frequency response plots, discrete integrator, discrete differentiator, development of digital PID controller, transfer function, design in the Z-plane.

### UNIT V PRACTICAL ASPECTS OF DIGITAL CONTROL ALGORITHMS 9

Algorithm development of PID control algorithms, standard programmes for microcontroller implementation, finite word length effects, choice of data acquisition systems, microcontroller based temperature control systems, microcontroller based motor speed control systems, DSP implementation of motor control system.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- Describe continuous time and discrete time controllers analytically.
- Define and state basic analog to digital and digital to analog conversion principles.
- Analyze sampled data control system in time and frequency domains.
- Design simple PI, PD, PID continuous and digital controllers.
- Develop schemes for practical implementation of temperature and motor control systems.

**REFERENCES:**

1. John J. D'Azzo, "Constantive Houpios, Linear Control System Analysis and Design", Mc Graw Hill,1995.
2. Kenneth J. Ayala, "The 8051 Microcontroller- Architecture, Programming and Applications", Penram International, 2<sup>nd</sup> Edition, 1996.
3. M.Gopal, "Digital Control and Static Variable Methods", Tata McGraw Hill, New Delhi, 1997.

**AP5001****COMPUTER ARCHITECTURE AND PARALLEL PROCESSING****L T P C  
3 0 0 3****OBJECTIVES:**

- Understand the difference between pipeline and parallel processing concepts
- Study various types of processor architectures and the importance of scalable architectures
- Study Memory Architectures, Memory Technology and Optimization.

**UNIT I COMPUTER DESIGN AND PERFORMANCE MEASURES****9**

Fundamentals of Computer Design – Parallel and Scalable Architectures – Multiprocessors –Multi-vector and SIMD architectures – Multithreaded architectures – Stanford Dash multiprocessor – KSR1 - Data-flow architectures - Performance Measures

**UNIT II PARALLEL PROCESSING, PIPELINING AND ILP****9**

Instruction Level Parallelism and Its Exploitation - Concepts and Challenges - Pipelining processors - Overcoming Data Hazards with Dynamic Scheduling – Dynamic Branch Prediction - Speculation - Multiple Issue Processors - Performance and Efficiency in Advanced Multiple Issue Processors

**UNIT III MEMORY HIERARCHY DESIGN****9**

Memory Hierarchy - Memory Technology and Optimizations – Cache memory – Optimizations of Cache Performance – Memory Protection and Virtual Memory - Design of Memory Hierarchies.

**UNIT IV MULTIPROCESSORS****9**

Symmetric and distributed shared memory architectures – Cache coherence issues – Performance Issues – Synchronization issues – Models of Memory Consistency - Interconnection networks – Buses, crossbar and multi-stage switches.

**UNIT V MULTI-CORE ARCHITECTURES****9**

Software and hardware multithreading – SMT and CMP architectures – Design issues – Case-studies – Intel Multi-core architecture – SUN CMP architecture – IBM cell architecture – hp architecture.

**TOTAL : 45 PERIODS****OUTCOMES:**

- Explain design of memory hierarchies
- Assess Performance Issues and Synchronization issues
- Compare multicore architectures

## REFERENCES:

1. David E. Culler, Jaswinder Pal Singh, "Parallel Computing Architecture: A hardware/ software approach", Morgan Kaufmann / Elsevier, 1997
2. Dimitrios Soudris, Axel Jantsch, "Scalable Multi-core Architectures: Design Methodologies and Tools", Springer, 2012
3. Hwang Briggs, "Computer Architecture and parallel processing", McGraw Hill, 1984.
4. John L. Hennessy and David A. Patterson, "Computer Architecture – A quantitative approach", Morgan Kaufmann / Elsevier, 4th. edition, 2007
5. John P. Hayes, "Computer Architecture and Organization", McGraw Hill
6. John P. Shen, "Modern processor design. Fundamentals of super scalar processors", Tata McGraw Hill 2003
7. Kai Hwang, "Advanced Computer Architecture", McGraw Hill International, 2001
8. William Stallings, "Computer Organization and Architecture – Designing for Performance", Pearson Education, Seventh Edition, 2006

**AP5002**

**CAD FOR VLSI CIRCUITS**

**L T P C  
3 0 0 3**

## OBJECTIVES:

- To study various physical design methods in VLSI.
- To understand the concepts behind the VLSI design rules and routing techniques.
- To understand the concepts of various algorithms used for floor planning and routing techniques.

### **UNIT I INTRODUCTION TO VLSI DESIGN FLOW**

**9**

Introduction to VLSI Design methodologies, Basics of VLSI design automation tools, Algorithmic Graph Theory and Computational Complexity, Tractable and Intractable problems, General purpose methods for combinatorial optimization.

### **UNIT II LAYOUT, PLACEMENT AND PARTITIONING**

**9**

Layout Compaction, Design rules, Problem formulation, Algorithms for constraint graph compaction, Placement and partitioning, Circuit representation, Placement algorithms, Partitioning

### **UNIT III FLOOR PLANNING AND ROUTING**

**9**

Floor planning concepts, Shape functions and floorplan sizing, Types of local routing problems, Area routing, Channel routing, Global routing, Algorithms for global routing.

### **UNIT IV SIMULATION AND LOGIC SYNTHESIS**

**9**

Simulation, Gate-level modeling and simulation, Switch-level modeling and simulation, Combinational Logic Synthesis, Binary Decision Diagrams, Two Level Logic Synthesis.

### **UNIT V HIGH LEVEL SYNTHESIS**

**9**

Hardware models for high level synthesis, internal representation, allocation, assignment and scheduling, scheduling algorithms, Assignment problem, High level transformations.

**TOTAL: 45 PERIODS**

## OUTCOMES:

- To use the simulation techniques at various levels in VLSI design flow
- Discuss the concepts of floor planning and routing
- Outline high level synthesis

## REFERENCES:

1. N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers, 2002.
2. S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons, 2002.
3. Sadiq M. Sait, Habib Youssef, "VLSI Physical Design automation: Theory and Practice", World scientific 1999.
4. Steven M. Rubin, "Computer Aids for VLSI Design", Addison Wesley Publishing 1987.

CU5292

ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

L T P C  
3 0 0 3

## OBJECTIVES:

The students should be made to be familiar with:

- The basics of EMI
- EMI sources.
- EMI problems.
- Solution methods in PCB.
- Measurements techniques for emission.
- Measurement techniques for immunity.

### UNIT I BASIC THEORY

9

Introduction to EMI and EMC, Intra and inter system EMI, Elements of Interference, Sources and Victims of EMI, Conducted and Radiated EMI emission and susceptibility, Case Histories, Radiation hazards to humans, Various issues of EMC, EMC Testing categories EMC Engineering Application.

### UNIT II COUPLING MECHANISM

9

Electromagnetic field sources and Coupling paths, Coupling via the supply network, Common mode coupling, Differential mode coupling, Impedance coupling, Inductive and Capacitive coupling, Radioactive coupling, Ground loop coupling, Cable related emissions and coupling, Transient sources, Automotive transients.

### UNIT III EMI MITIGATION TECHNIQUES

9

Working principle of Shielding and Murphy's Law, LF Magnetic shielding, Apertures and shielding effectiveness, Choice of Materials for H, E, and free space fields, Gasketting and sealing, PCB Level shielding, Principle of Grounding, Isolated grounds, Grounding strategies for Large systems, Grounding for mixed signal systems, Filter types and operation, Surge protection devices, Transient Protection.

### UNIT IV STANDARD AND REGULATION

9

Need for Standards, Generic/General Standards for Residential and Industrial environment, Basic Standards, Product Standards, National and International EMI Standardizing Organizations; IEC, ANSI, FCC, AS/NZS, CISPR, BSI, CENELEC, ACEC. Electro Magnetic Emission and susceptibility standards and specifications, MIL461E Standards.

## **UNIT V EMI TEST METHODS AND INSTRUMENTATION**

**9**

Fundamental considerations, EMI Shielding effectiveness tests, Open field test, TEM cell for immunity test, Shielded chamber, Shielded anechoic chamber, EMI test receivers, Spectrum analyzer, EMI test wave simulators, EMI coupling networks, Line impedance stabilization networks, Feed through capacitors, Antennas, Current probes, MIL -STD test methods, Civilian STD test methods.

**TOTAL: 45 PERIODS**

### **OUTCOMES:**

**At the end of this course, the student should be able to:**

- Identify Standards
- Compare EMI test methods
- Discuss EMI mitigation techniques

### **REFERENCES:**

1. Bemhard Keiser, "Principles of Electromagnetic Compatibility", 3<sup>rd</sup> Ed, Artech house, Norwood, 1986.
2. Clayton Paul, "Introduction to Electromagnetic Compatibility", Wiley Interscience, 2006.
3. Daryl Gerke and William Kimmel, "EDN's Designer's Guide to Electromagnetic Compatibility", Elsevier Science & Technology Books, 2002
4. Dr Kenneth L Kaiser, "The Electromagnetic Compatibility Handbook", CRC Press 2005.
5. Electromagnetic Compatibility by Norman Violette, Published by Springer, 2013
6. Electromagnetic Interference and Compatibility: Electrical noise and EMI specifications Volume 1 of A Handbook Series on Electromagnetic Interference and Compatibility, Donald R. J. White Publisher-Don white consultants Original from the University of Michigan Digitized 6 Dec 2007
7. Henry W. Ott, "Electromagnetic Compatibility Engineering", John Wiley & Sons Inc, Newyork, 2009
8. V Prasad Kodali, "Engineering Electromagnetic Compatibility", IEEE Press, Newyork, 2001.
9. W Scott Bennett, "Control and Measurement of Unintentional Electromagnetic Radiation", John Wiley & Sons Inc., (Wiley Interscience Series) 1997.

**AP5003**

**VLSI DESIGN TECHNIQUES**

**L T P C  
3 0 0 3**

### **OBJECTIVES:**

- This course deals comprehensively with all aspects of transistor level design of all the digital building blocks common to all CMOS microprocessors, DSPs, network processors, digital backend of all wireless systems etc.
- The focus will be on the transistor level design and will address all important issues related to size, speed and power consumption. The units are classified according to the important building and will introduce the principles and design methodology in terms of the dominant circuit choices, constraints and performance measures.

## **UNIT I MOS TRANSISTOR PRINCIPLES AND CMOS INVERTER**

**12**

MOS(FET) Transistor Characteristic under Static and Dynamic Conditions, MOS Transistor Secondary Effects, Process Variations, Technology Scaling, Internet Parameter and electrical wise models CMOS Inverter - Static Characteristic, Dynamic Characteristic, Power, Energy, and Energy Delay parameters.

|  |  |          |
|--|--|----------|
| <b>UNIT II</b>   | <b>COMBINATIONAL LOGIC CIRCUITS</b>                        | <b>9</b> |
| Propagation Delays, Stick diagram, Layout diagrams, Examples of combinational logic design, Elmore's constant, Dynamic Logic Gates, Pass Transistor Logic, Power Dissipation, Low Power Design principles. |  |          |
| <b>UNIT III</b>  | <b>SEQUENTIAL LOGIC CIRCUITS</b>                           | <b>9</b> |
| Static Latches and Registers, Dynamic Latches and Registers, Timing Issues, Pipelines, Pulse and sense amplifier based Registers, Nonbistable Sequential Circuits.   |  |          |
| <b>UNIT IV</b>   | <b>ARITHMETIC BUILDING BLOCKS AND MEMORY ARCHITECTURES</b> | <b>9</b> |
| Data path circuits, Architectures for Adders, Accumulators, Multipliers, Barrel Shifters, Speed and Area Tradeoffs, Memory Architectures, and Memory control circuits.                                     |  |          |
| <b>UNIT V</b>  | <b>INTERCONNECT AND CLOCKING STRATEGIES</b>                | <b>6</b> |
| Interconnect Parameters – Capacitance, Resistance, and Inductance, Electrical Wire Models, Timing classification of Digital Systems, Synchronous Design, Self-Timed Circuit Design.                        |  |          |

**TOTAL : 45 PERIODS**

**OUTCOMES:**

**At the end of the course, the student should be able to:**

- Carry out transistor level design of the most important building blocks used in digital CMOS VLSI circuits.
- Discuss design methodology of arithmetic building block
- Analyze tradeoffs of the various circuit choices for each of the building block.

**REFERENCES:**

1. Jacob Baker "CMOS: Circuit Design, Layout, and Simulation, Third Edition", Wiley IEEE Press 2010.
2. Jan Rabaey, Anantha Chandrakasan, B Nikolic, "Digital Integrated Circuits: A Design Perspective". Prentice Hall of India 2<sup>nd</sup> Edition, Feb 2003,
3. M J Smith, "Application Specific Integrated Circuits", Addison Wesley, 1997
4. N.Weste, K. Eshraghian, "Principles of CMOS VLSI Design". Addison Wesley, 2<sup>nd</sup> Edition, 1993

**AP5071**

**NANOELECTRONICS**

**L T P C**  
**3 0 0 3**

**OBJECTIVES**

- To understand how transistor as Nano device
- To understand various forms of Nano Devices
- To understand the Nano Sensors

|  |                                   |          |
|--|-----------------------------------|----------|
| <b>UNIT I</b>  | <b>SEMICONDUCTOR NANO DEVICES</b> | <b>9</b> |
| Single-Electron Devices; Nano scale MOSFET – Resonant Tunneling Transistor - Single-Electron Transistors; Nanorobotics and Nanomanipulation; Mechanical Molecular Nanodevices; Nanocomputers: Optical Fibers for Nanodevices; Photochemical Molecular Devices; DNA-Based Nanodevices; Gas-Based Nanodevices. |                                   |          |

**UNIT II ELECTRONIC AND PHOTONIC MOLECULAR MATERIALS 9**

Preparation – Electroluminescent Organic materials - Laser Diodes - Quantum well lasers:- Quantum cascade lasers- Cascade surface-emitting photonic crystal laser- Quantum dot lasers - Quantum wire lasers:- White LEDs - LEDs based on nanowires - LEDs based on nanotubes - LEDs based on nanorods - High Efficiency Materials for OLEDs- High Efficiency Materials for OLEDs - Quantum well infrared photo detectors.

**UNIT III THERMAL SENSORS 9**

Thermal energy sensors -temperature sensors, heat sensors - Electromagnetic sensors - electrical resistance sensors, electrical current sensors, electrical voltage sensors, electrical power sensors, magnetism sensors - Mechanical sensors - pressure sensors, gas and liquid flow sensors, position sensors - Chemical sensors - Optical and radiation sensors.

**UNIT IV GAS SENSOR MATERIALS 9**

Criteria for the choice of materials - Experimental aspects – materials, properties, measurement of gas sensing property, sensitivity; Discussion of sensors for various gases, Gas sensors based on semiconductor devices.

**UNIT V BIOSENSORS 9**

Principles - DNA based biosensors – Protein based biosensors – materials for biosensor applications - fabrication of biosensors - future potential.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- To be able to simulate and design the nano device
- To be able to simulate and design the nano sensors

**REFERENCES:**

1. K.E. Drexler, “Nano systems”, Wiley, 1992.
2. M.C. Petty, “Introduction to Molecular Electronics”, 1995.
3. W. Ranier, “Nano Electronics and Information Technology”, Wiley, 2003.

|               |   |          |          |          |          |
|---------------|---|----------|----------|----------|----------|
| <b>CU5097</b> | <b>WIRELESS ADHOC AND SENSOR NETWORKS</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|               |   | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**OBJECTIVES:**

- To understand the basics of Ad-hoc & Sensor Networks.
- To learn various fundamental and emerging protocols of all layers.
- To study about the issues pertaining to major obstacles in establishment and efficient management of Ad-hoc and sensor networks.
- To understand the nature and applications of Ad-hoc and sensor networks.
- To understand various security practices and protocols of Ad-hoc and Sensor Networks.

**UNIT I MAC & TCP IN AD HOC NETWORKS 9**

Fundamentals of WLANs – IEEE 802.11 Architecture - Self configuration and Auto configuration-Issues in Ad-Hoc Wireless Networks – MAC Protocols for Ad-Hoc Wireless Networks – Contention Based Protocols - TCP over Ad-Hoc networks-TCP protocol overview - TCP and MANETs – Solutions for TCP over Ad-Hoc Networks.



**OBJECTIVES:**

- To develop a comprehensive understanding of multimedia networking.
- To study the types of VPN and tunneling protocols for security.
- To learn about network security in many layers and network management.

**UNIT I INTRODUCTION****9**

Review of OSI, TCP/IP; Multiplexing, Modes of Communication, Switching, Routing. SONET – DWDM – DSL – ISDN – BISDN, ATM.

**UNIT II MULTIMEDIA NETWORKING APPLICATIONS****9**

Streaming stored Audio and Video – Best effort service – protocols for real time interactive applications – Beyond best effort – scheduling and policing mechanism – integrated services – RSVP- differentiated services.

**UNIT III ADVANCED NETWORKS CONCEPTS****9**

VPN-Remote-Access VPN, site-to-site VPN, Tunneling to PPP, Security in VPN. MPLS- operation, Routing, Tunneling and use of FEC, Traffic Engineering, MPLS based VPN, overlay networks- P2P connections.

**UNIT IV TRAFFIC MODELLING****9**

Little's theorem, Need for modeling, Poisson modeling and its failure, Non- poisson models, Network performance evaluation.

**UNIT V NETWORK SECURITY AND MANAGEMENT****9**

Principles of cryptography – Authentication – integrity – key distribution and certification – Access control and: fire walls – attacks and counter measures – security in many layers. Infrastructure for network management – The internet standard management framework – SMI, MIB, SNMP, Security and administration – ASN.1

**TOTAL: 45PERIODS****OUTCOMES:**

**Upon completion of this course, the students should be able to:**

- Discuss advanced networks concepts
- Outline traffic modeling
- Evaluate network security

**REFERENCES:**

1. Aunurag Kumar, D. M Anjunath, Joy Kuri, "Communication Networking", Morgan Kaufmann Publishers, 1<sup>st</sup> edition 2004.
2. Fred Halsall and Lingana Gouda Kulkarni, "Computer Networking and the Internet", fifth edition, Pearson education 2006
3. Hersent Gurle & Petit, "IP Telephony, packet Pored Multimedia communication Systems", Pearson education 2003
4. J.F. Kurose & K.W. Ross, "Computer Networking- A top down approach featuring the internet", Pearson, 2<sup>nd</sup> edition, 2003
5. Larry I. Peterson & Bruce S. David, "Computer Networks: A System Approach"- 1996
6. LEOM-GarCIA, WIDJAJA, "Communication networks", TMH seventh reprint 2002.
7. Nader F. Mir, Computer and Communication Networks, first edition 2010
8. Walrand .J. Varatya, High performance communication network, Morgan Kauffman – Harcourt Asia Pvt. Ltd. 2<sup>nd</sup> Edition, 2000



**OBJECTIVES:**

- The CMOS RF Front End (RFE) is a very crucial building block and in all of wireless and many high frequency wire-line systems. The RFE has few important building blocks within it including the Low Noise Amplifiers, Phase Locked Loop Synthesizers, Mixers, Power Amplifiers, and impedance matching circuits.
- The present course will introduce the principles of operation and design principles associated with these important blocks.
- The course will also provide and highlight the appropriate digital communication related design objectives and constraints associated with the RFEs

**UNIT I CMOS PHYSICS, TRANSCEIVER SPECIFICATIONS AND ARCHITECTURES****9**

Introduction to MOSFET Physics, Noise: Thermal, shot, flicker, popcorn noise, Two port Noise theory, Noise Figure, THD, IP2, IP3, Sensitivity, SFDR, Phase noise - Specification distribution over a communication link, Homodyne Receiver, Heterodyne Receiver, Image reject, Low IF Receiver Architectures Direct upconversion Transmitter, Two step upconversion Transmitter.

**UNIT II IMPEDANCE MATCHING AND AMPLIFIERS****9**

S-parameters with Smith chart, Passive IC components, Impedance matching networks, Common Gate, Common Source Amplifiers, OC Time constants in bandwidth estimation and enhancement, High frequency amplifier design, Power match and Noise match, Single ended and Differential LNAs, Terminated with Resistors and Source Degeneration LNAs.

**UNIT III FEEDBACK SYSTEMS AND POWER AMPLIFIERS****9**

Stability of feedback systems: Gain and phase margin, Root-locus techniques, Time and Frequency domain considerations, Compensation, General model – Class A, AB, B, C, D, E and F amplifiers, Power amplifier Linearisation Techniques, Efficiency boosting techniques, ACPR metric, Design considerations.

**UNIT IV MIXERS AND OSCILLATORS****9**

Mixer characteristics, Non-linear based mixers, Quadratic mixers, Multiplier based mixers, Single balanced and double balanced mixers, subsampling mixers, Oscillators describing Functions, Colpitts oscillators Resonators, Tuned Oscillators, Negative resistance oscillators, Phase noise.

**UNIT V PLL AND FREQUENCY SYNTHESIZERS****9**

Linearised Model, Noise properties, Phase detectors, Loop filters and Charge pumps, Integer-N frequency synthesizers, Direct Digital Frequency synthesizers.

**TOTAL : 45 PERIODS****OUTCOMES:**

- The student after completing this course must be able to translate the top level wireless communications system specifications into block level specifications of the RFE.
- The student should be also able to carry out transistor level design of the entire RFE.

**REFERENCES:**

1. B.Razavi, "Design of Analog CMOS Integrated Circuits", McGraw Hill, 2001
2. B.Razavi, "RF Microelectronics", Pearson Education, 1997.
3. Jan Crols, Michiel Steyaert, "CMOS Wireless Transceiver Design", Kluwer Academic Publishers, 1997.
4. Recorded lectures and notes available at . <http://www.ee.iitm.ac.in/~ani/ee6240/>
5. T.Lee, "Design of CMOS RF Integrated Circuits", Cambridge, 2004.

**OBJECTIVES:**

- To study basic concepts of processing speech and audio signals
- To study and analyse various M-band filter-banks for audio coding
- To understand audio coding based on transform coders.
- To study time and frequency domain speech processing methods

**UNIT I MECHANICS OF SPEECH AND AUDIO****9**

Introduction - Review of Signal Processing Theory-Speech production mechanism – Nature of Speech signal – Discrete time modelling of Speech production – Classification of Speech sounds – Phones – Phonemes – Phonetic and Phonemic alphabets – Articulatory features. Absolute Threshold of Hearing - Critical Bands- Simultaneous Masking, Masking-Asymmetry, and the Spread of Masking- Non-simultaneous Masking - Perceptual Entropy - Basic measuring philosophy -Subjective versus objective perceptual testing - The perceptual audio quality measure (PAQM) - Cognitive effects in judging audio quality.

**UNIT II TIME-FREQUENCY ANALYSIS: FILTER BANKS AND TRANSFORMS****9**

Introduction - Analysis-Synthesis Framework for M-band Filter Banks- Filter Banks for Audio Coding: Design Considerations - Quadrature Mirror and Conjugate Quadrature Filters - Tree-Structured QMF and CQF M-band Banks - Cosine Modulated “Pseudo QMF” M-band Banks -Cosine Modulated Perfect Reconstruction (PR) M-band Banks and the Modified Discrete Cosine Transform (MDCT) - Discrete Fourier and Discrete Cosine Transform - Pre-echo Distortion- Pre-echo Control Strategies

**UNIT III AUDIO CODING AND TRANSFORM CODERS****9**

Lossless Audio Coding – Lossy Audio Coding - ISO-MPEG-1A, 2A, 2A-Advanced, 4A Audio Coding - Optimum Coding in the Frequency Domain - Perceptual Transform Coder –Brandenburg - Johnston Hybrid Coder - CNET Coders - Adaptive Spectral Entropy Coding –Differential Perceptual Audio Coder - DFT Noise Substitution -DCT with Vector Quantization -MDCT with Vector Quantization

**UNIT IV TIME AND FREQUENCY DOMAIN METHODS FOR SPEECH PROCESSING****9**

Time domain parameters of Speech signal – Methods for extracting the parameters :Energy, Average Magnitude – Zero crossing Rate – Silence Discrimination using ZCR and energy Short Time Fourier analysis – Formant extraction – Pitch Extraction using time and frequency domain methods Homomorphic Speech Analysis: Cepstral analysis of Speech – Formant and Pitch Estimation – Homomorphic Vocoders

**UNIT V PREDICTIVE ANALYSIS OF SPEECH****9**

Formulation of Linear Prediction problem in Time Domain – Basic Principle – Auto correlation method – Covariance method – Solution of LPC equations – Cholesky method – Durbin’s Recursive algorithm – lattice formation and solutions – Comparison of different methods – Application of LPC parameters – Pitch detection using LPC parameters – Formant analysis – VELP – CELP

**TOTAL : 45 PERIODS****OUTCOMES:**

**Upon completion of this course, the students should be able to:**

- Evaluate audio coding and transform coders
- Discuss time and frequency domain methods for speech processing
- Explain predictive analysis of speech

**REFERENCES:**

1. B.Gold and N.Morgan, "Speech and Audio Signal Processing", Wiley and Sons, 2000.
2. L.R.Rabiner and R.W.Schaffer, "Digital Processing of Speech Signals", Prentice Hall, 1978.
3. Mark Kahrs, Karlheinz Brandenburg, Kluwer Applications of Digital Signal Processing to Audio And Acoustics, Academic Publishers,
4. Udo Zölzer, "Digital Audio Signal Processing", Second Edition A John Wiley& sons Ltd

**AP5092**

**SOLID STATE DEVICE MODELLING AND SIMULATION**

**L T P C  
3 0 0 3**

**OBJECTIVES:**

- To understand the concept of device modeling
- To learn multistep method
- To study device simulations

**UNIT I MOSFET DEVICE PHYSICS MOSFET**

**9**

capacitor, Basic operation, Basic modeling, Advanced MOSFET modeling, RF modeling of MOS transistors, Equivalent circuit representation of MOS transistor, High frequency behavior of MOS transistor and A.C small signal modeling, model parameter extraction, modeling parasitic BJT, Resistors, Capacitors, Inductors.

**UNIT II DEVICE MODELLING**

**9**

Prime importance of circuit and device simulations in VLSI; Nodal, mesh, modified nodal and hybrid analysis equations. Solution of network equations: Sparse matrix techniques, solution of nonlinear networks through Newton-Raphson technique, convergence and stability.

**UNIT III MULTISTEP METHODS**

**9**

Solution of stiff systems of equations, adaptation of multistep methods to the solution of electrical networks, general purpose circuit simulators.

**UNIT IV MATHEMATICAL TECHNIQUES DEVICE SIMULATIONS**

**9**

Poisson equation, continuity equation, drift-diffusion equation, Schrodinger equation, hydrodynamic equations, trap rate, finite difference solutions to these equations in 1D and 2D space, grid generation.

**UNIT V SIMULATION OF DEVICES**

**9**

Computation of characteristics of simple devices like p-n junction, MOS capacitor and MOSFET; Small-signal analysis.

**TOTAL :45PERIODS**

**OUTCOMES:**

**Upon completion of this course, the students should be able to:**

- Explain the importance of MOS Capacitor and Small signal modeling
- Apply and determine the drift diffusion equation and stiff system equation.
- Analyze circuits using parasitic BJT parameters and newton Raphson method.
- Model the MOS transistor using schrodinger equation and Multistep methods.

**REFERENCES:**

1. Arora, N., "MOSFET Modeling for VLSI Simulation", Cadence Design Systems, 2007
2. Chua, L.O. and Lin, P.M., "Computer-Aided Analysis of Electronic Circuits: Algorithms and Computational Techniques", Prentice-Hall., 1975
3. Fjeldly, T., Yetterdal, T. and Shur, M., "Introduction to Device Modeling and Circuit Simulation", Wiley-Interscience., 1997
4. Grasser, T., "Advanced Device Modeling and Simulation", World Scientific Publishing Company., 2003
5. Selberherr, S., "Analysis and Simulation of Semiconductor Devices", Springer- Verlag., 1984
6. Trond Ytterdal, Yuhua Cheng and Tor A. FjeldlyWayne Wolf, "Device Modeling for Analog and RF CMOS Circuit Design", John Wiley & Sons Ltd.

**CP5292**

**INTERNET OF THINGS**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**OBJECTIVES:**

- To understand the fundamentals of Internet of Things
- To learn about the basics of IOT protocols
- To build a small low cost embedded system using Raspberry Pi.
- To apply the concept of Internet of Things in the real world scenario

**UNIT I INTRODUCTION TO IoT**

**9**

Internet of Things - Physical Design- Logical Design- IoT Enabling Technologies - IoT Levels & Deployment Templates - Domain Specific IoTs - IoT and M2M - IoT System Management with NETCONF-YANG- IoT Platforms Design Methodology

**UNIT II IoT ARCHITECTURE**

**9**

M2M high-level ETSI architecture - IETF architecture for IoT - OGC architecture - IoT reference model - Domain model - information model - functional model - communication model - IoT reference architecture

**UNIT III IoT PROTOCOLS**

**9**

Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNet Protocol – Modbus– Zigbee Architecture – Network layer – 6LowPAN - CoAP - Security

**UNIT IV BUILDING IoT WITH RASPBERRY PI & ARDUINO**

**9**

Building IOT with RASPERRY PI- IoT Systems - Logical Design using Python – IoT Physical Devices & Endpoints - IoT Device -Building blocks -Raspberry Pi -Board - Linux on Raspberry Pi - Raspberry Pi Interfaces -Programming Raspberry Pi with Python - Other IoT Platforms - Arduino.

**UNIT V CASE STUDIES AND REAL-WORLD APPLICATIONS**

**9**

Real world design constraints - Applications - Asset management, Industrial automation, smart grid, Commercial building automation, Smart cities - participatory sensing - Data Analytics for IoT – Software & Management Tools for IoT Cloud Storage Models & Communication APIs - Cloud for IoT - Amazon Web Services for IoT.

**TOTAL :45 PERIODS**

**OUTCOMES:**

Upon completion of this course, the students should be able to:

- Analyze various protocols for IoT
- Develop web services to access/control IoT devices.
- Design a portable IoT using Raspberry Pi
- Deploy an IoT application and connect to the cloud.
- Analyze applications of IoT in real time scenario

**REFERENCES:**

1. Arshdeep Bahga, Vijay Madiseti, "Internet of Things – A hands-on approach", Universities Press, 2015
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.
3. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press, 2012.
4. Jan Ho" ller, Vlasios Tsiatsis , Catherine Mulligan, Stamatias , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.
5. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols", Wiley, 2012

**AP5005****SYSTEM ON CHIP DESIGN**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**OBJECTIVES:**

- understanding of the concepts, issues, and process of designing highly integrated SoCs following systematic hardware/software co-design & co-verification principles

**UNIT I INTRODUCTION****9**

Introduction to SoC Design, system level design, methodologies and tools, system hardware: IO, communication, processing units, memories; operating systems: prediction of execution, real time scheduling, embedded OS, middle ware; Platform based SoC design, multiprocessor SoC and Network on Chip, Low power SoC Design

**UNIT II SYSTEM LEVEL MODELLING****9**

SystemC: overview, Data types, modules, notion of time, dynamic process, basic channels, structure communication, ports and interfaces, Design with examples

**UNIT III HARDWARE SOFTWARE CO-DESIGN****9**

Analysis, partitioning, high level optimisations, real-time scheduling, hardware acceleration, voltage scaling and power management; Virtual platform models, co-simulation and FPGAs for prototyping of HW/SW systems.

**UNIT IV SYNTHESIS****9**

System synthesis: Transaction Level Modelling (TLM) based design, automaticTLM generation and mapping, platform synthesis; software synthesis: code generation, multi task synthesis, internal and external communication; Hardware synthesis: RTL architecture, Input models, estimation and optimisation, resource sharing and pipelining and scheduling

**UNIT V SOC VERIFICATION AND TESTING**

**9**

SoC and IP integration, Verification : Verification technology options, verification methodology, overview: system level verification, physical verification, hardware/software co-verification; Test requirements and methodologies, SoC design for testability - System modeling, test power dissipation, test access mechanism

**TOTAL : 45 PERIODS**

**OUTCOMES:**

- Analyse algorithms and architecture of hardware software in order to optimise the system based on requirements and implementation constraints
- Model and specify systems at high level of abstraction
- appreciate the co-design approach and virtual platform models
- Understand hardware, software and interface synthesis

**REFERENCES**

1. D. Black, J. Donovan, SystemC: From the Ground Up, Springer, 2004.
2. D. Gajski, S. Abdi, A. Gerstlauer, G. Schirner, Embedded System Design: Modeling, Synthesis, Verification, Springer, 2009
3. Erik Larson, Introduction to advanced system-on-chip test design and optimisation, Springer 2005
4. Grotker, T., Liao, S., Martin, G. & Swan, S. System design with System C, Springer, 2002.
5. Ghenassia, F. Transaction-level modeling with SystemC: TLM concepts and applications for embedded systems, Springer, 2010.
6. Hoi-junyoo, Kangmin Lee, Jun Kyoungkim, "Low power NoC for high performance SoC design", CRC press, 2008.
7. M. L. Bushnell and V.D. Agrawal, Essentials of Electronic Testing for Digital Memory and Mixed Signal VLSI Circuits, Springer, 2005
8. M. Abramovici, M. Breuer, and A. Friedman, Digital System Testing and Testable Design, IEEE Press, 1994
9. P. Marwedel, Embedded System Design, Springer, 2003. G. De Micheli, Synthesis and Optimization of Digital Circuits
10. Prakash Rashinkar, Peter Paterson and Leena Singh, System-on-a chip verification: Methodology and techniques, kluwer Academic Publishers 2002
11. T. Noergaard, Embedded Systems Architecture: A Comprehensive Guide for Engineers and Programmers, Newnes.
12. Vijay K. Madiseti Chonlameth Arpikanondt, "A Platform-Centric Approach to System-on-Chip (SOC) Design", Springer, 2005.
13. Youn-Long Steve Lin, Essential Issues in SOC Design Designing Complex Systems-on-Chip, Springer, 2006

**AP5093**

**ROBOTICS**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**OBJECTIVES:**

- To understand robot locomotion and mobile robot kinematics
- To understand perception in robotics
- To understand mobile robot localization
- To understand mobile robot mapping
- To understand simultaneous localization and mapping (SLAM)
- To understand robot planning and navigation

|   |                                  |          |
|---|----------------------------------|----------|
| <b>UNIT I</b>   | <b>LOCOMOTION AND KINEMATICS</b> | <b>9</b> |
| Introduction to Robotics – key issues in robot locomotion – legged robots – wheeled mobile robots – aerial mobile robots – introduction to kinematics – kinematics models and constraints – robot maneuverability   |                                  |          |
| <b>UNIT II</b>  | <b>ROBOT PERCEPTION</b>          | <b>9</b> |
| Sensors for mobile robots – vision for robotics – cameras – image formation – structure from stereo – structure from motion – optical flow – color tracking – place recognition – range data  |                                  |          |
| <b>UNIT III</b>   | <b>MOBILE ROBOT LOCALIZATION</b> | <b>9</b> |
| Introduction to localization – challenges in localization – localization and navigation – belief representation – map representation – probabilistic map-based localization – Markov localization – EKF localization – UKF localization – Grid localization – Monte Carlo localization – localization in dynamic environments |                                  |          |
| <b>UNIT IV</b>  | <b>MOBILE ROBOT MAPPING</b>      | <b>9</b> |
| Autonomous map building – occupancy grid mapping – MAP occupancy mapping – SLAM – extended Kalman Filter SLAM – graph-based SLAM – particle filter SLAM – sparse extended information filter – fastSLAM algorithm.  |                                  |          |
| <b>UNIT V</b>   | <b>PLANNING AND NAVIGATION</b>   | <b>9</b> |
| Introduction to planning and navigation – planning and reacting – path planning – obstacle avoidance techniques – navigation architectures – basic exploration algorithms   |                                  |          |

**TOTAL 45 PERIODS**

**OUTCOMES:**

**Upon Completion of the course, the students will be able to**

- Explain robot locomotion
- Apply kinematics models and constraints
- Implement vision algorithms for robotics
- Implement robot localization techniques
- Implement robot mapping techniques
- Implement SLAM algorithms
- Explain planning and navigation in robotics

**REFERENCES:**

1. Gregory Dudek and Michael Jenkin, “Computational Principles of Mobile Robotics”, Second Edition, Cambridge University Press, 2010.
2. Howie Choset et al., “Principles of Robot Motion: Theory, Algorithms, and Implementations”, A Bradford Book, 2005.
3. Maja J. Mataric, “The Robotics Primer”, MIT Press, 2007.
4. Roland Siegwart, Illah Reza Nourbakhsh, and Davide Scaramuzza, “Introduction to autonomous mobile robots”, Second Edition, MIT Press, 2011.
5. Sebastian Thrun, Wolfram Burgard, and Dieter Fox, “Probabilistic Robotics”, MIT Press, 2005.

**OBJECTIVES:**

- To introduce the physical design concepts such as routing, placement, partitioning and packaging
- To study the performance of circuits layout designs, compaction techniques.

**UNIT I INTRODUCTION TO VLSI TECHNOLOGY 9**

Layout Rules-Circuit abstraction Cell generation using programmable logic array transistor chaining, Wein Berger arrays and gate matrices-layout of standard cells gate arrays and sea of gates, field programmable gate array(FPGA)-layout methodologies Packaging-Computational Complexity - Algorithmic Paradigms.

**UNIT II PLACEMENT USING TOP-DOWN APPROACH 9**

Partitioning: Approximation of Hyper Graphs with Graphs, Kernighan-Lin Heuristic Ratio cut partition with capacity and i/o constraints. Floor planning: Rectangular dual floor planning hierarchical approach- simulated annealing- Floor plan sizing Placement: Cost function- force directed method- placement by simulated annealing partitioning placement- module placement on a resistive network – regular placement linear placement.

**UNIT III ROUTING USING TOP DOWN APPROACH 9**

Fundamentals: Maze Running- line searching- Steiner trees Global Routing: Sequential Approaches - hierarchical approaches - multi commodity flow based techniques - Randomised Routing- One Step approach - Integer Linear Programming Detailed Routing: Channel Routing - Switch box routing. Routing in FPGA: Array based FPGA- Row based FPGAs

**UNIT IV PERFORMANCE ISSUES IN CIRCUIT LAYOUT 9**

Delay Models: Gate Delay Models- Models for interconnected Delay- Delay in RC trees. Timing – Driven Placement: Zero Stack Algorithm- Weight based placement- Linear Programming Approach Timing riving Routing: Delay Minimization- Click Skew Problem- Buffered Clock Trees. Minimization: constrained via Minimization unconstrained via Minimization- Other issues in minimization

**UNIT V SINGLE LAYER ROUTING, CELL GENERATION AND COMPACTION 9**

Planar subset problem(PSP)- Single Layer Global Routing- Single Layer detailed Routing- Wire length and bend minimization technique – Over The Cell (OTC) Routing Multiple chip modules(MCM)- programmable Logic Arrays- Transistor chaining- Wein Burger Arrays- Gate matrix layout- 1D compaction- 2D compaction.

**TOTAL: 45 PERIODS****OUTCOMES:****Upon Completion of the course, the students will be able to**

- Explain different types of routing
- Discuss performance issues in circuit layout
- Outline 1D compaction- 2D compaction.

**REFERENCES:**

1. Preas M. Lorenzatti, "Physical Design and Automation of VLSI systems", The Benjamin Cummins Publishers, 1998.
2. Sarafzadeh, C.K. Wong, "An Introduction to VLSI Physical Design", McGraw Hill Int. Edition 1995

**OBJECTIVES:**

- To identify sources affecting the speed of digital circuits.
- To introduce methods to improve the signal transmission characteristics

**UNIT I SIGNAL PROPAGATION ON TRANSMISSION LINES 9**

Transmission line equations, wave solution, wave vs. circuits, initial wave, delay time, Characteristic impedance, wave propagation, reflection, and bounce diagrams Reactive terminations – L, C, static field maps of micro strip and strip line cross-sections, per unit length parameters, PCB layer stackups and layer/Cu thicknesses, cross-sectional analysis tools, Zo and Td equations for microstrip and stripline Reflection and terminations for logic gates, fan-out, logic switching, input impedance into a transmission-line section, reflection coefficient, skin-effect, dispersion

**UNIT II MULTI-CONDUCTOR TRANSMISSION LINES AND CROSS-TALK 9**

Multi-conductor transmission-lines, coupling physics, per unit length parameters, Near and far-end cross-talk, minimizing cross-talk (stripline and microstrip) Differential signalling, termination, balanced circuits, S-parameters, Lossy and Lossless models

**UNIT III NON-IDEAL EFFECTS 9**

Non-ideal signal return paths – gaps, BGA fields, via transitions, Parasitic inductance and capacitance, Transmission line losses – Rs,  $\tan\delta$ , routing parasitic, Common-mode current, differential-mode current, Connectors

**UNIT IV POWER CONSIDERATIONS AND SYSTEM DESIGN 9**

SSN/SSO, DC power bus design, layer stack up, SMT decoupling, Logic families, power consumption, and system power delivery, Logic families and speed Package types and parasitic, SPICE, IBIS models, Bit streams, PRBS and filtering functions of link-path components, Eye diagrams, jitter, inter-symbol interference Bit-error rate, Timing analysis

**UNIT V CLOCK DISTRIBUTION AND CLOCK OSCILLATORS 9**

Timing margin, Clock slew, low impedance drivers, terminations, Delay Adjustments, canceling parasitic capacitance, Clock jitter.

**TOTAL : 45 PERIODS****OUTCOMES:**

- Ability to identify sources affecting the speed of digital circuits.
- Able to improve the signal transmission characteristics.

**REFERENCES:**

1. Douglas Brooks, Signal Integrity Issues and Printed Circuit Board Design, Prentice Hall PTR, 2003
2. Eric Bogatin, Signal Integrity – Simplified, Prentice Hall PTR, 2003.
3. H. W. Johnson and M. Graham, High-Speed Digital Design: A Handbook of Black Magic, Prentice Hall, 1993.
4. S. Hall, G. Hall, and J. McCall, High-Speed Digital System Design: A Handbook of Interconnect Theory and Design Practices, Wiley-Interscience, 2000.

**TOOLS REQUIRED**

1. SPICE, source - <http://www-cad.eecs.berkeley.edu/Software/software.html>
2. HSPICE from synopsis, [www.synopsys.com/products/mixedsignal/hspice/hspice.html](http://www.synopsys.com/products/mixedsignal/hspice/hspice.html)
3. SPECCTRAQUEST from Cadence, <http://www.spectraquest.com>

**OBJECTIVES:**

- To introduce the concepts of microelectromechanical devices.
- To know the fabrication process of Microsystems.
- To know the design concepts of micro sensors and micro actuators.
- To familiarize concepts of quantum mechanics and nano systems.

**UNIT I OVERVIEW****9**

New trends in Engineering and Science: Micro and Nanoscale systems, Introduction to Design of MEMS and NEMS, MEMS and NEMS – Applications, Devices and structures. Materials for MEMS: Silicon, silicon compounds, polymers, metals.

**UNIT II MEMS FABRICATION TECHNOLOGIES****9**

Microsystem fabrication processes: Photolithography, Ion Implantation, Diffusion, Oxidation. Thin film depositions: LPCVD, Sputtering, Evaporation, Electroplating; Etching techniques: Dry and wet etching, electrochemical etching; Micromachining: Bulk Micromachining, Surface Micromachining, High Aspect- Ratio (LIGA and LIGA-like) Technology; Packaging: Microsystems packaging, Essential packaging technologies, Selection of packaging materials.

**UNIT III MICRO SENSORS****9**

MEMS Sensors: Design of Acoustic wave sensors, resonant sensor, Vibratory gyroscope, Capacitive and Piezo Resistive Pressure sensors- engineering mechanics behind these Microsensors. Case study: Piezo-resistive pressure sensor.

**UNIT IV MICRO ACTUATORS****9**

Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces (Parallel plate, Torsion bar, Comb drive actuators), Micromechanical Motors and pumps. Case study: Comb drive actuators.

**UNIT V NANOSYSTEMS AND QUANTUM MECHANICS****9**

Atomic Structures and Quantum Mechanics, Molecular and Nanostructure Dynamics: Schrodinger Equation and Wave function Theory, Density Functional Theory, Nanostructures and Molecular Dynamics, Electromagnetic Fields and their quantization, Molecular Wires and Molecular Circuits.

**TOTAL: 45 PERIODS****OUTCOMES:**

**At the end of this course, the student should be able to:**

- Discuss micro sensors
- Explain micro actuators
- Outline nanosystems and Quantum mechanics

**REFERENCES:**

1. Chang Liu, "Foundations of MEMS", Pearson education India limited, 2006.
2. Marc Madou, "Fundamentals of Microfabrication", CRC press 1997
3. Stephen D. Senturia, "Micro system Design", Kluwer Academic Publishers, 2001
4. Sergey Edward Lyshevski, "MEMS and NEMS: Systems, Devices, and Structures" CRC Press, 2002.
5. Tai Ran Hsu, "MEMS and Microsystems Design and Manufacture", Tata McGraw Hill, 2002



AP5008

PATTERN RECOGNITION

L T P C  
3 0 0 3

**OBJECTIVES:**

- To learn about supervised and unsupervised pattern classifiers.
- To familiarize about different feature extraction techniques.
- To explore the role of Hidden Marko model and SVM in pattern recognition.
- To understand the application of Fuzzy logic and genetic algorithms for pattern classifier

**UNIT I PATTERN CLASSIFIER 9**

Overview of Pattern recognition – Discriminant functions – Supervised learning – Parametric estimation – Maximum Likelihood Estimation – Bayesian parameter Estimation – Problems with Bayes approach– Pattern classification by distance functions – Minimum distance pattern classifier.

**UNIT II CLUSTERING 9**

Clustering for unsupervised learning and classification–Clustering concept – C Means algorithm – Hierarchical clustering – Graph theoretic approach to pattern Clustering – Validity of Clusters.

**UNIT III FEATURE EXTRACTION AND STRUCTURAL PATTERN RECOGNITION 9**

Principle component analysis, Independent component analysis, Linear discriminant analysis, Feature selection through functional approximation – Elements of formal grammars, Syntactic description – Stochastic grammars – Structural Representation.

**UNIT IV HIDDEN MARKOV MODELS AND SUPPORT VECTOR MACHINE 9**

State Machines – Hidden Markov Models – Training – Classification – Support vector Machine – Feature Selection.

**UNIT V RECENT ADVANCES 9**

Fuzzy logic – Fuzzy Pattern Classifiers – Pattern Classification using Genetic Algorithms – Case Study Using Fuzzy Pattern Classifiers and Perception.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

**Upon completion of the course the student will be able to**

- Differentiate between supervised and unsupervised classifiers
- Classify the data and identify the patterns.
- Extract feature set and select the features from given data set.
- Apply fuzzy logic and genetic algorithms for classification problems

**REFERENCES:**

1. Andrew Webb, "Stastical Pattern Recognition", Arnold publishers, London, 1999
2. C.M.Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
3. M. Narasimha Murthy and V. Susheela Devi, "Pattern Recognition", Springer 2011.
4. Menahem Friedman , Abraham Kandel, "Introduction to Pattern Recognition Statistical, Structural, Neural and Fuzzy Logic Approaches", World Scientific publishing Co. Ltd, 2000.
5. Robert J.Schalkoff, "Pattern Recognition Statistical, Structural and Neural Approaches", John Wiley & Sons Inc., New York, 1992.
6. R.O.Duda, P.E.Hart and D.G.Stork, "Pattern Classification", John Wiley, 2001
7. S.Theodoridis and K.Koutroumbas, "Pattern Recognition", 4<sup>th</sup> Ed., Academic Press. 2009.