

# Indian Institute of Information Technology Bhagalpur

## Computer Science and Engineering (CSE)

### B.Tech. Course Curricula and Syllabus

#### *Semester-VII*

#### Curricula:

| Course Code           | Course name                       | L | T | P | C |
|-----------------------|-----------------------------------|---|---|---|---|
| <a href="#">HS401</a> | Professional Ethics for Engineers | 2 | 0 | 0 | 2 |
|                       | <a href="#">Elective – II</a>     | 3 | 1 | 0 | 4 |
|                       | <a href="#">Elective – III</a>    | 3 | 1 | 0 | 4 |
|                       | <a href="#">Open Elective</a>     | 3 | 1 | 0 | 4 |
| HS45X                 | Foreign Language                  | 0 | 0 | 2 | 2 |
| EC491                 | Minor Project                     | 0 | 0 | 6 | 4 |
| SAI III               | Industry Internship               | 0 | 0 | 0 | 2 |

#### Syllabus:

| Course Code                                                                                                                                                                                   | Course name                                                                                                                                                                                                                                                                                                                                                | L               | T | P | C | Year            | Semester        |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---|---|---|-----------------|-----------------|
| HS401                                                                                                                                                                                         | Professional Ethics in Engineers                                                                                                                                                                                                                                                                                                                           | 2               | 0 | 0 | 2 | 4 <sup>th</sup> | 7 <sup>th</sup> |
| Course objective: To enable the students to create an awareness on Engineering Ethics and Human Values, to instil Moral and Social Values and Loyalty and to appreciate the rights of others. |                                                                                                                                                                                                                                                                                                                                                            |                 |   |   |   |                 |                 |
| Topic                                                                                                                                                                                         | Contents                                                                                                                                                                                                                                                                                                                                                   | No. of Lectures |   |   |   |                 |                 |
| Module-I                                                                                                                                                                                      | HUMAN VALUES: Morals, Values and Ethics, Integrity, Work ethic, Service learning, Civic virtue, Respect for others, Living peacefully, Caring, Sharing, Honesty, Courage, Valuing time, Cooperation, Commitment, Empathy, Self-confidence, Character- Spirituality, Introduction to Yoga and meditation for professional excellence and Stress management. | 05              |   |   |   |                 |                 |
| Module-II                                                                                                                                                                                     | ENGINEERING ETHICS: Senses of Engineering ethics, Variety of moral issues, types of inquiry- Moral dilemmas, Moral Autonomy, Kohlberg's theory, Gilligan's theory, Consensus and Controversy, Models of professional roles, Theories of right action, Self-interest, Customs and Religion, Uses of Ethical theories.                                       | 05              |   |   |   |                 |                 |
| Module-III                                                                                                                                                                                    | ENGINEERING AS SOCIAL EXPERIMENTATION: Engineering as Experimentation, Engineers as responsible experimenters, Code of ethics, A Balanced Outlook on Law                                                                                                                                                                                                   | 04              |   |   |   |                 |                 |
| Module-IV                                                                                                                                                                                     | SAFETY, RESPONSIBILITIES AND ETHICS: Safety and Risk, Assessment of Safety and risk, Risk Benefit Analysis and Reducing Risk, Respect for authority, Collective Bargaining, Confidentiality, Conflict of interest, Occupational crime, Professional Rights, Employee Rights, Intellectual Property Rights (IPR), Discrimination                            | 05              |   |   |   |                 |                 |

|          |                                                                                                                                                                                                                                                                    |    |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Module-V | GLOBAL ISSUES: Multinational Corporations, Environmental Ethics, Computer ethics, Weapons Development, Engineers as managers, Consulting engineers, Engineers as Expert Witnesses and Advisors, Moral Leadership, Code of conduct, Corporate Social Responsibility | 05 |
| Total    |                                                                                                                                                                                                                                                                    | 24 |
| Text     | 1. Mike W Martin and Roland Schinzinger, <i>Ethics in Engineering</i> , Tata McGraw Hill, 2003.<br>2. Govindarajan M, Natarajan S, Senthil Kumar V S, <i>Engineering Ethics</i> , Prentice Hall of India, 2004.                                                    |    |

## Elective-II

### List of choices

| Course code           | Course Name                          | Area of Specialization          |
|-----------------------|--------------------------------------|---------------------------------|
| <a href="#">CS451</a> | VLSI Design Verification and Testing | [Hardware & Systems]            |
| <a href="#">CS452</a> | Foundations of Cloud Computing       | [Hardware & Systems]            |
| <a href="#">CS453</a> | Computational Geometry               | [Theory & Machine intelligence] |
| <a href="#">CS454</a> | Information Retrieval                | [Theory & Machine intelligence] |
| <a href="#">CS455</a> | Wireless Sensor Network              | [Network & Security]            |
| <a href="#">CS456</a> | Network Security                     | [Network & Security]            |

### Syllabus for Elective-II Courses

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Course name                                                                                        | L               | T | P | C | Year            | Semester        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|-----------------|---|---|---|-----------------|-----------------|
| CS451                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | VLSI Design Verification and Testing                                                               | 3               | 1 | 0 | 4 | 4 <sup>th</sup> | 7 <sup>th</sup> |
| <b>Course Objective:</b> The goal of this course is to provide students with an overall understanding of basic concepts in the Design, Verification, and Testing of VLSI Circuits and Systems. The course introduces students with the basic design and synthesis of hardware systems, system verification, testing of combinational and sequential circuits. It will also enhance the students' ability to understand various fault simulation and testability measures for modern digital hardware systems. |                                                                                                    |                 |   |   |   |                 |                 |
| Topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Contents                                                                                           | No. of Lectures |   |   |   |                 |                 |
| Module 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Introduction to VLSI Design; Scheduling, Allocation and Binding; Logic Optimization and Synthesis. | 10              |   |   |   |                 |                 |
| Module 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Binary Decision Diagram; Temporal Logic; Model Checking.                                           | 8               |   |   |   |                 |                 |
| Module 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Introduction to Digital Testing; Fault Simulation and Testability Measures.                        | 8               |   |   |   |                 |                 |

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| Module 4         | Combinational Circuit Test Pattern Generation: Automatic Test Pattern Generation (ATPG) and ATPG Algebras; D-Algorithm.<br><br>Sequential Circuit Testing and Scan Chains: ATPG for Synchronous Sequential Circuits; Scan Chain based Sequential Circuit Testing.                                                                                                                                                                            | <b>10</b> |
| Module 5         | Built in Self-Test (BIST), Memory Testing                                                                                                                                                                                                                                                                                                                                                                                                    | <b>4</b>  |
|                  | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>40</b> |
|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |
| <b>Text</b>      | 1. Algorithms for VLSI Physical Design Automation, Naveed A. Sherwani, Springer; Softcover reprint of the original 3rd ed. 1999 edition (3 October 2013)<br><br>2. Michael Huth and Mark Ryan, Logic in Computer Science: Modelling and Reasoning about Systems, Cambridge University Press, 2018.<br>3. M. Bushnell, Vishwani Agrawal, Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits, Springer, 2013. |           |
| <b>Reference</b> | 1.Samir Palnitkar, "Verilog HDL: a guide to digital design and synthesis", 2 nd Edition, Prentice Hall Press, 2003.<br>2.Wolf W., Modern VLSI Design, Pearson Education, 1997.<br>3.Michael Nicolaidis, Yervant Zorian, Dhiraj Pradhan, On-Line Testing for VLSI, Springer, 2010.                                                                                                                                                            |           |

| Course Code                                                                                                                                                                                                                                                                               | Course name                                                                                                                                                                                                                         | L               | T | P | C | Year | Semester |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---|---|---|------|----------|
| CS452                                                                                                                                                                                                                                                                                     | Foundations of Cloud Computing                                                                                                                                                                                                      | 3               | 1 | 0 | 4 | 4    | 7        |
| <b>Course Objective:</b> The goal of this course is to provide an overview of cloud computing concepts. In this course students learn the cloud architecture and infrastructure. The student also learn about various programming platforms to implement and work with the cloud systems. |                                                                                                                                                                                                                                     |                 |   |   |   |      |          |
| Topic                                                                                                                                                                                                                                                                                     | Contents                                                                                                                                                                                                                            | No. of Lectures |   |   |   |      |          |
| Module 1                                                                                                                                                                                                                                                                                  | Introduction: Distributed System Models and Enabling Technologies, Defining Cloud Computing: Service Models, Deployment Models, Characteristics of Cloud Computing.                                                                 | <b>7</b>        |   |   |   |      |          |
| Module 2                                                                                                                                                                                                                                                                                  | Cloud Architectures, Service and Applications: Exploring the Cloud Computing Stack, Infrastructure, Platforms, Virtual Appliances, Communication Protocols, Applications, Cloud Service and Applications by type: IaaS, PaaS, SaaS. | <b>8</b>        |   |   |   |      |          |
| Module 3                                                                                                                                                                                                                                                                                  | Virtualization: Virtualization Structures, Tools and Mechanisms, Virtualization of CPU, Memory and I/O Devices, Virtualization for Data-Centre Automation.                                                                          | <b>7</b>        |   |   |   |      |          |

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|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| Module 4         | Programming Paradigms – Parallel and Distributed programming paradigms: Map Reduce , Iterative Map Reduce:, Hadoop Library from Apache, Programming Support: Google App Engine, Amazon AWS, Cloud Software Environments: Eucalyptus, Open Nebula, OpenStack.                                                                                                                  | <b>7</b>  |
| Module 5         | Cloud Security: Securing the cloud, Data Security, Network Security, Host Security, Disaster Recovery Planning and Management in the Cloud.                                                                                                                                                                                                                                   | <b>6</b>  |
|                  | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                  | <b>35</b> |
|                  |                                                                                                                                                                                                                                                                                                                                                                               |           |
| <b>Text</b>      | 1. Kai Hwang, Geoffrey C. Fox and Jack J. Dongarra, Distributed and Cloud Computing from Parallel Processing to the Internet of Things, 2012<br>2. Barrie Sosinsky, Cloud Computing Bible, 2010                                                                                                                                                                               |           |
| <b>Reference</b> | 1. Buyya R., Broberg J., Goscinski A. M., Cloud Computing – Principles and Paradigms, 2011.<br>2. Toby Velte, Anthony Velte, Robert Elsenpeter, Cloud Computing, A Practical Approach, 2009.<br>3. Resse G., Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, 2009.<br>4. Dan C Marinescu, Cloud Computing, Theory and Practice, 2013. |           |

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Course name                                                                                                                         | L               | T | P | C | Year            | Semester        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|-----------------|---|---|---|-----------------|-----------------|
| CS453                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Computational Geometry</b>                                                                                                       | 3               | 1 | 0 | 4 | 4 <sup>th</sup> | 7 <sup>th</sup> |
| <b>Course Objective:</b> The goal of this course is to provide students with an overall understanding of the field as a research discipline which can on the one hand be explained from the beauty of the problems studied and the solutions obtained, and, on the other hand, by the many application domains—computer graphics, geographic information systems (GIS), robotics, and others—in which geometric algorithm splay a fundamental role. It will also enhance the students with a number of new algorithmic techniques that have been developed, improved, and simplified many of the previous approaches in recent years. |                                                                                                                                     |                 |   |   |   |                 |                 |
| Topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Contents                                                                                                                            | No. of Lectures |   |   |   |                 |                 |
| Module 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Introduction to Computational Geometry: Convex Hulls, Degeneracies and Robustness, and Application Domains.                         | <b>2</b>        |   |   |   |                 |                 |
| Module 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Line Segment Intersection- Thematic Map Overlay, and Polygon Triangulation- Guarding an Art Gallery.                                | <b>6</b>        |   |   |   |                 |                 |
| Module 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Linear Programming- Manufacturing with Molds, Orthogonal Range Searching, Point Location, Voronoi Diagrams, Delaunay Triangulations | <b>14</b>       |   |   |   |                 |                 |
| Module 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | More Geometric Data Structures, Binary Space Partitions                                                                             | <b>8</b>        |   |   |   |                 |                 |
| Module 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Robot Motion Planning, Quad trees, and Visibility Graphs.                                                                           | <b>10</b>       |   |   |   |                 |                 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Total</b>                                                                                                                        | <b>40</b>       |   |   |   |                 |                 |

|                  |                                                                                                                                                                                                                                                                                                             |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Text</b>      | 1. Mark de Berg, Otfried Cheong, Marc van Kreveld, Mark Overmars, Computational Geometry Algorithms and Applications, Springer, 2008.                                                                                                                                                                       |
| <b>Reference</b> | 1. Joseph O'Rourke, Computational Geometry in C, Cambridge University Press, 2012.<br>2. Satyan L. Devadoss, Joseph O'Rourke, Discrete and Computational Geometry, Princeton University Press, 2011.<br>3. Franco P. Preparata, Michael I. Shamos, Computational Geometry: An Introduction, Springer, 1993. |

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Course name                                                                                                                                                                                                                                                             | L | T | P | C | Year            | Semester        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|-----------------|-----------------|
| CS454                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Information Retrieval                                                                                                                                                                                                                                                   | 3 | 1 | 0 | 4 | 4 <sup>th</sup> | 7 <sup>th</sup> |
| <b>Course Objective:</b> The goal of this course is to provide students with an overview of Information Retrieval inside which students have insights of the several topics of Information retrieval such as – Boolean retrieval model, Vector space model, Latent semantic indexing, XML and Image retrieval model. It will also help students to know about evaluation methods of the information retrieval model and the challenges associated with each topic. |                                                                                                                                                                                                                                                                         |   |   |   |   |                 |                 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                         |   |   |   |   |                 |                 |
| Topic                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Contents                                                                                                                                                                                                                                                                |   |   |   |   |                 | No. of Lectures |
| Module 1                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Introduction to Information retrieval, Dictionary and Postings                                                                                                                                                                                                          |   |   |   |   |                 | 5               |
| Module 2                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Tolerant Retrieval, Term Weighting and Vector Space Model.                                                                                                                                                                                                              |   |   |   |   |                 | 7               |
| Module 3                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Evaluation: Precision, Recall, F-measure, E-measure, Normalized recall, Evaluation problems. Latent Semantic Indexing                                                                                                                                                   |   |   |   |   |                 | 10              |
| Module 4                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Query Expansion and Probabilistic Information Retrieval                                                                                                                                                                                                                 |   |   |   |   |                 | 10              |
| Module 5                                                                                                                                                                                                                                                                                                                                                                                                                                                           | XML Indexing and Search, Content Based Image Retrieval.                                                                                                                                                                                                                 |   |   |   |   |                 | 10              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Total                                                                                                                                                                                                                                                                   |   |   |   |   |                 | 42              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                         |   |   |   |   |                 |                 |
| Text                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 1. Christopher D. Manning, Raghavan Prabhakar, Schütze Hinrich, Introduction to Information Retrieval, Cambridge University Press, 2008.<br>2. Tanveer Siddiqui and U. S. Tiwary, Natural Language Processing and Information Retrieval, Oxford University Press, 2008. |   |   |   |   |                 |                 |
| Reference                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 1. Stefan Buttcher, Information Retrieval – Implementing and Evaluating Search Engines, MIT Press, 2016.<br>2. Yale and Neto, Modern Information Retrieval, Pearson, 2003.                                                                                              |   |   |   |   |                 |                 |

| Course Code | Course name              | L | T | P | C | Year            | Semester        |
|-------------|--------------------------|---|---|---|---|-----------------|-----------------|
| CS455       | Wireless Sensor Networks | 3 | 1 | 0 | 4 | 4 <sup>th</sup> | 7 <sup>th</sup> |

| <b>Course Objective:</b> The objective of this course is to provide students an overview of Wireless Sensor Networks. The students learn issues and challenges related to WSN design, and implementation. The course provide required knowledge to students to build real-time WSN applications. |                                                                                                                                                                                                                                          |                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| Topic                                                                                                                                                                                                                                                                                            | Contents                                                                                                                                                                                                                                 | No. of Lectures |
| Module 1                                                                                                                                                                                                                                                                                         | Introduction: Sensor Nodes, Sensor node Platforms, WSN Architecture and Protocol Stack, WSN Applications, WSN Hardware Constraints, Fault Tolerance, Scalability, Production Costs, WSN Topology, Transmission Media, Power Consumption. | 7               |
| Module 2                                                                                                                                                                                                                                                                                         | WSN Physical layer: Overview of RF Wireless Communication, Technologies and Standards, WSN Channel Coding and Modulation, Wireless Channel Effects, MAC and Error Handling.                                                              | 7               |
| Module 3                                                                                                                                                                                                                                                                                         | WSN Network Layer: Routing Protocols: Data Centric, Hierarchical, Location, and QoS based Routing Protocols, WSN Transport and Application Layer Protocols.                                                                              | 7               |
| Module 4                                                                                                                                                                                                                                                                                         | Time Synchronization: Timing and Synchronization Protocols, Localization: Ranging Techniques, Range-Based and Range-Free Localization Protocols, Topology Management.                                                                    | 7               |
| Module 5                                                                                                                                                                                                                                                                                         | Wireless Sensor and Actor Networks, Wireless Multimedia and Underwater Sensor Networks.                                                                                                                                                  | 7               |
|                                                                                                                                                                                                                                                                                                  | <b>Total</b>                                                                                                                                                                                                                             | <b>35</b>       |
| <b>Text</b>                                                                                                                                                                                                                                                                                      | 1. Ian F. Akyildiz, Mehmet Can Vuran, Wireless Sensor Networks, Thomson, 2010.<br>2. Kazem Sohraby, Daniel Minoli and Taieb Znati, Wireless Sensor Networks Technology, Protocols, and Applications, John Wiley & Sons, 2007.            |                 |
| <b>Reference</b>                                                                                                                                                                                                                                                                                 | 1. Holger Karl and Andreas Willig, Protocols and Architectures for Wireless Sensor Networks, John Wiley & Sons, Ltd, 2005.<br>2. Anna Ha'c, Wireless Sensor Network Designs, John Wiley & Sons Ltd.                                      |                 |

| Course Code                                                                                                                                                                                                                                                                                 | Course name                                                                                                                                                                            | L               | T | P | C | Year            | Semester        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---|---|---|-----------------|-----------------|
| CS456                                                                                                                                                                                                                                                                                       | Network Security                                                                                                                                                                       | 3               | 1 | 0 | 4 | 4 <sup>th</sup> | 7 <sup>th</sup> |
| <b>Course Objective:</b> The objective of this course is to study the network security methodologies. In the course students learn cryptographic algorithms, issues related to real-time communication security, electronic mail security, network vulnerabilities and Web security issues. |                                                                                                                                                                                        |                 |   |   |   |                 |                 |
| Topic                                                                                                                                                                                                                                                                                       | Contents                                                                                                                                                                               | No. of Lectures |   |   |   |                 |                 |
| Module 1                                                                                                                                                                                                                                                                                    | Network Security Introduction: Networks Basics: OSI Model, IP. TCP, UDP, Packet Switching, Cryptography: Cryptography Basics, Secret Key Cryptography: Data Encryption Standard (DES). | 6               |   |   |   |                 |                 |

|                  |                                                                                                                                                                                                                                                                                                                                                              |           |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| Module 2         | Encrypting a Large Message: Electronic Code Book (ECB), Cipher Block Chaining (CBC), Output Feedback Mode (OFB), Cipher Feedback Mode (CFB), Counter Mode (CTR), Multiple Encryption DES, Hashes and Message Digests,                                                                                                                                        | <b>8</b>  |
| Module 3         | Public Key Cryptography, Public Key Algorithms: RSA, Public-Key Cryptography Standard (PKCS), Number Theory: Euclid's Algorithm, Euler Theorem. Authentication: Overview of Authentication Systems, Authentication of People, Security Handshake Pitfalls, Trusted Intermediaries                                                                            | <b>8</b>  |
| Module 4         | Real-Time Communication Security: IPsec: AH and ESP, IPsec: IKE, SSL/TLS                                                                                                                                                                                                                                                                                     | <b>6</b>  |
| Module 5         | Electronic Mail Security: Distribution Lists, Establishing Keys, Privacy, Authentication of the Source, Message Integrity, Non-Repudiation, Proof of Submission, Proof of Delivery, Message Flow Confidentiality, Anonymity, Pretty Good Privacy (PGP), Firewalls and Web Issues: Packet Filters, Application Level Gateways, Cookies, Web Security Problems | <b>7</b>  |
|                  | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                 | <b>35</b> |
|                  |                                                                                                                                                                                                                                                                                                                                                              |           |
| <b>Text</b>      | 1. Charlie Kaufman, Radia Perlman, and Mike Speciner, Network Security: Private Communication in a Public World, 2002.                                                                                                                                                                                                                                       |           |
| <b>Reference</b> | 1. Behrouz A Forouzan, Debdeep Mukhopadhyay, Cryptography and Network Security, 2015<br>2. William Stallings, Cryptography and Network Security Principles and Practices, 2005.<br>3. Douglas Stinson, Cryptography Theory and Practice, 2005.                                                                                                               |           |

## Elective-III

### List of choices

| Course code           | Course Name                                  | Area of Specialization          |
|-----------------------|----------------------------------------------|---------------------------------|
| <a href="#">CS471</a> | Introduction to Networks on Chip             | [Hardware & Systems]            |
| <a href="#">CS472</a> | Introduction to Multimedia Systems           | [Hardware & Systems]            |
| <a href="#">CS473</a> | Parallel Algorithms                          | [Theory & Machine intelligence] |
| <a href="#">CS474</a> | Introduction to Deep Learning                | [Theory & Machine intelligence] |
| <a href="#">CS475</a> | Introduction to Cyber Security and Forensics | [Network & Security]            |
| <a href="#">CS476</a> | Introduction to Hardware Security            | [Network & Security]            |

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Course name                                                                                                                                                                                                                                                                                                                                                                                                                                                           | L               | T | P | C | Year            | Semester        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---|---|---|-----------------|-----------------|
| CS471                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Introduction to Networks on Chip                                                                                                                                                                                                                                                                                                                                                                                                                                      | 3               | 1 | 0 | 4 | 4 <sup>th</sup> | 7 <sup>th</sup> |
| <p><b>Course Objective:</b> The goal of this course is to provide students with an overall understanding of basic concepts in the implementation of networks-on-chip (NoC) technology in VLSI integration including a variety of unique challenges. The course introduces students with detailing the NoC paradigm and its benefits in separating IP design and functionality from chip communication requirements and interfacing. It will also enhance the students' ability to understand important emerging research issues, such as, resource allocation for quality of service (QoS) on-chip communication, Testing, verification, and network design methodologies, architectures for interconnection, real-time monitoring, and security requirements, and networks-on-chip protocols.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |   |   |   |                 |                 |
| Topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                              | No. of Lectures |   |   |   |                 |                 |
| Module 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | The Evolution of NoC from SoC, Interconnection Networks in Network-on-Chip.                                                                                                                                                                                                                                                                                                                                                                                           | 4               |   |   |   |                 |                 |
| Module 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Architecture Design of Network-on-Chip, Evaluation of Network-on-Chip Architectures, Routing and Flow Control.                                                                                                                                                                                                                                                                                                                                                        | 6               |   |   |   |                 |                 |
| Module 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Networks-on-Chip Protocols, Verification of Communications in Networks-on-Chips.                                                                                                                                                                                                                                                                                                                                                                                      | 6               |   |   |   |                 |                 |
| Module 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Application Mapping on Network-on-Chip, Resource Allocation for QoS On-Chip Communication, Energy and Power Issues in Network-on-Chips.                                                                                                                                                                                                                                                                                                                               | 10              |   |   |   |                 |                 |
| Module 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Signal Integrity and Reliability of Network-on-Chip, Testing of Network-on- Chip Architectures, Test and Fault Tolerance for NoC Infrastructures, Reconfigurable Network-on-Chip Design, Security in NoCs                                                                                                                                                                                                                                                             | 14              |   |   |   |                 |                 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>40</b>       |   |   |   |                 |                 |
| <b>Text Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <ol style="list-style-type: none"> <li>1. Giovanni De Micheli, Luca Benini, Davide Bertozzi, Networks on Chips: Technology and Tools, Morgan Kaufmann, 2006.</li> <li>2. Fayez Gebali, Haytham Elmiligi, Mohamed Watheq El-Kharashi, Networks-on-Chips: Theory and Practice, CRC Press, 2017.</li> <li>3. Santanu Kundu, Santanu Chattopadhyay, Network-on-Chip: The Next Generation of System-on-Chip Integration, CRC Press, 2014.</li> </ol>                       |                 |   |   |   |                 |                 |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <ol style="list-style-type: none"> <li>1. Sudeep Pasricha, Nikil Dutt, On-Chip Communication Architectures: System on Chip Interconnect, Morgan Kaufmann, 2010.</li> <li>2. José Flich and Davide Bertozzi, Designing Network On-Chip Architectures in the Nanoscale Era, Chapman and Hall/CRC, 2011.</li> <li>3. Laung-Terng Wang, Charles E. Stroud, Nur A. Toubia, System-On-Chip Test Architectures: Nanometer Design For Testability, Elsevier, 2008.</li> </ol> |                 |   |   |   |                 |                 |



| Course Code                                                                                                                                                                                                                                                                                                                                      | Course name                                                                                                                                                                                                                                                                             | L               | T | P | C | Year            | Semester        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---|---|---|-----------------|-----------------|
| CS472                                                                                                                                                                                                                                                                                                                                            | Introduction to Multimedia Systems                                                                                                                                                                                                                                                      | 3               | 1 | 0 | 4 | 4 <sup>th</sup> | 7 <sup>th</sup> |
| <b>Course Objective:</b> Multimedia data has become an indispensable part of our daily life. It's also one of the critical links in the ongoing unification of computing and communications. In this course, students will be introduced to principles and current technologies of multimedia systems and gain hands-on experience in this area. |                                                                                                                                                                                                                                                                                         |                 |   |   |   |                 |                 |
| Topic                                                                                                                                                                                                                                                                                                                                            | Contents                                                                                                                                                                                                                                                                                | No. of Lectures |   |   |   |                 |                 |
| Module 1                                                                                                                                                                                                                                                                                                                                         | Introduction to Multimedia System: An overview of multimedia system and media streams architecture and components, synchronization & quality of service (QOS).                                                                                                                          | 5               |   |   |   |                 |                 |
| Module 2                                                                                                                                                                                                                                                                                                                                         | Audio and Speech: Data acquisition, sampling and quantization, human speech, digital model of speech production, analysis and synthesis, psychoacoustics, low bit rate speech compression, MPEG audio compression.                                                                      | 7               |   |   |   |                 |                 |
| Module 3                                                                                                                                                                                                                                                                                                                                         | Images and Video: Image acquisition and representation, bi-level image compression standards: ITU (formerly CCITT) Group III and IV standards, JPEG image compression standards, MPEG, H.264/AVC video compression standards, Transcoding.                                              | 8               |   |   |   |                 |                 |
| Module 4                                                                                                                                                                                                                                                                                                                                         | Multimedia Communication: Fundamentals of data communication and networking, Bandwidth requirements of different media, Real time constraints: latency, video data rate, multimedia over LAN and WAN, Multimedia conferencing, video-on-demand broadcasting issues.                     | 8               |   |   |   |                 |                 |
| Module 5                                                                                                                                                                                                                                                                                                                                         | Multimedia Information Systems: Operating system support for continuous media applications: Media stream protocol, file system support for continuous media, data models for multimedia and hypermedia information, multimedia servers, databases and content management.               | 7               |   |   |   |                 |                 |
|                                                                                                                                                                                                                                                                                                                                                  | <b>Total</b>                                                                                                                                                                                                                                                                            | <b>35</b>       |   |   |   |                 |                 |
| <b>Text Books</b>                                                                                                                                                                                                                                                                                                                                | 1. Jerry D. Gibson, Toby Berger, Tom Lookabaugh, Dave Lindergh and Richard L. Baker Digital Compression for Multimedia: Principles and Standards Elsevier, 2006.<br>2. Ralf Steinmetz and Klara Nahrstedt, Multimedia: Computing, Communications, and Application, Prentice Hall, 1995. |                 |   |   |   |                 |                 |
| <b>Reference Books</b>                                                                                                                                                                                                                                                                                                                           | 1. Khalid Sayood Introduction to Data Compression 3rd Edition, Elsevier, 2006.<br>2. Asit Dan and Dinkar Sitaram Multimedia Servers Elsevier, 2006.                                                                                                                                     |                 |   |   |   |                 |                 |

| Course Code                                                                                                                                                                                                                                           | Course name                                                                                                                                                                                                                                                     | L | T | P | C | Year            | Semester        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|-----------------|-----------------|
| CS473                                                                                                                                                                                                                                                 | Parallel Algorithms                                                                                                                                                                                                                                             | 3 | 1 | 0 | 4 | 4 <sup>th</sup> | 7 <sup>th</sup> |
| <b>Course Objective:</b> A parallel algorithm assumes that there are multiple processors! This course is going to explore many algorithmic design techniques in the parallel setting. Parallel complexity theory will also be studied in this course. |                                                                                                                                                                                                                                                                 |   |   |   |   |                 |                 |
|                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                 |   |   |   |   |                 |                 |
| Topic                                                                                                                                                                                                                                                 | Contents                                                                                                                                                                                                                                                        |   |   |   |   |                 | No. of Lectures |
| Module 1                                                                                                                                                                                                                                              | Theoretical models of parallel computation: PRAM, interconnection networks Performance of parallel algorithms, Basic techniques.                                                                                                                                |   |   |   |   |                 | 5               |
| Module 2                                                                                                                                                                                                                                              | Comparator Networks, Odd Even Merge Sort, Bitonic Sort Merge Sort, Optimal List ranking, applications.                                                                                                                                                          |   |   |   |   |                 | 7               |
| Module 3                                                                                                                                                                                                                                              | Algorithms for searching, merging, Dense Matrix algorithms.                                                                                                                                                                                                     |   |   |   |   |                 | 8               |
| Module 4                                                                                                                                                                                                                                              | Graph algorithms, Linear Array, Meshes Sorting in meshes, Hypercube algorithms.                                                                                                                                                                                 |   |   |   |   |                 | 7               |
| Module 5                                                                                                                                                                                                                                              | Butterfly network, ccc, benes network, Limits to parallelizability. NC-reductions, P-completeness                                                                                                                                                               |   |   |   |   |                 | 8               |
|                                                                                                                                                                                                                                                       | Total                                                                                                                                                                                                                                                           |   |   |   |   |                 | 35              |
|                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                 |   |   |   |   |                 |                 |
| Text Books                                                                                                                                                                                                                                            | 1. Aki, Selim G. "The design and analysis of parallel algorithms." (1989).<br>2. JáJá, Joseph. An introduction to parallel algorithms, Addison-Wesley, 1992.                                                                                                    |   |   |   |   |                 |                 |
| Reference Books                                                                                                                                                                                                                                       | 1. Leighton, F. Thomson. Introduction to parallel algorithms and architectures: Arrays· trees· hypercubes. Elsevier, 2014.<br>2. Keller, Jörg, Christoph Kessler, and Jesper Träff. Practical PRAM programming. WileyInterscience, J. Wiley & Sons, Inc., 2001. |   |   |   |   |                 |                 |

| Course Code                                                                                                                                                                                                                                                         | Course name                                                                                                  | L               | T | P | C | Year            | Semester        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|-----------------|---|---|---|-----------------|-----------------|
| CS474                                                                                                                                                                                                                                                               | Introduction to Deep Learning                                                                                | 3               | 0 | 0 | 3 | 4 <sup>th</sup> | 7 <sup>th</sup> |
| <b>Course Objective:</b> This course discusses theoretical aspects of a deep learning algorithms and frameworks. This advanced level course will cover the latest techniques used to create artificially intelligent agents that can solve a variety complex tasks. |                                                                                                              |                 |   |   |   |                 |                 |
| Topic                                                                                                                                                                                                                                                               | Contents                                                                                                     | No. of Lectures |   |   |   |                 |                 |
| Module 1                                                                                                                                                                                                                                                            | Introduction: Various paradigms of learning problems, Review of Feedforward neural network, Perspectives and | 5               |   |   |   |                 |                 |

|                        |                                                                                                                                                                                                          |           |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|                        | Issues in deep learning framework, review of fundamental learning techniques.                                                                                                                            |           |
| Module 2               | Convolutional Neural Network (CNN): Construction of foundational layers of CNNs (pooling, convolutions) and to stack them properly in a deep network to solve multi-class image classification problems. | <b>7</b>  |
| Module 3               | Recurrent Neural Network (RNN): Fundamental feature of a RNN, Build your own recurrent networks and long short-term memory networks with PyTorch.                                                        | <b>8</b>  |
| Module 4               | Generative Adversarial Networks: Learn to understand a Deep Convolutional GAN (generative adversarial network) to generate realistic images.                                                             | <b>8</b>  |
| Module 5               | Case studies: Train and deploy your own deep learning model for object recognition, sentiment analysis, natural language processing through various deep learning tools.                                 | <b>7</b>  |
|                        | <b>Total</b>                                                                                                                                                                                             | <b>35</b> |
|                        |                                                                                                                                                                                                          |           |
| <b>Text Books</b>      | 1. Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. Deep learning. MIT press, 2016.                                                                                                                  |           |
| <b>Reference Books</b> | 2. Francois Chollet, Deep Learning with Python, Manning Publications, 2017.<br>3. Patterson, Josh, and Adam Gibson. Deep learning: A practitioner's approach. " O'Reilly Media, Inc.", 2017.             |           |

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Course name                                                                                                                                                                                                                                                                                                                                                                                                                                                 | L               | T | P | C | Year            | Semester        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---|---|---|-----------------|-----------------|
| CS475                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Introduction to Cyber Security and Forensics</b>                                                                                                                                                                                                                                                                                                                                                                                                         | 3               | 1 | 0 | 4 | 4 <sup>th</sup> | 7 <sup>th</sup> |
| <b>Course Objective:</b> The goal of this course is to provide students with a broad coverage of technical and socio-economic perspectives for utilizing information and communication technologies and developing practical solutions in cyber security, cybercrime, and cyber forensics. It will also enhance the students with the awareness's created through simple practical tips and tricks, educate them to learn how to avoid becoming victims of cybercrime. |                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                 |   |   |   |                 |                 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                 |   |   |   |                 |                 |
| Topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                    | No. of Lectures |   |   |   |                 |                 |
| Module 1                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Introduction to Cybercrime: Who are Cybercriminals? Classifications of Cybercrimes, The legal Perspectives and Indian Perspective, Cybercrime and the Indian ITA 2000, and A Global Perspective on Cybercrimes. Present and Future Cybercrime.<br>Introduction to Cyber Offenses: How Criminals Plan Them? How Criminals Plan the Attacks, Social Engineering, Cyber stalking, Cyber cafe and Cybercrimes? Botnets: The Fuel for Cybercrime, Attack Vector. | <b>08</b>       |   |   |   |                 |                 |

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |           |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| Module 2         | Tools and Methods Used in Cybercrime: Mobile and Wireless Devices, Proxy Servers and Anonymizers, Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Trojan Horse and Backdoors, Steganography, DoS and DDoS attacks, SQL Injection, Buffer Overflow.                                                                                                                                                                                                                                                                         | <b>10</b> |
| Module 3         | Cyber Security: Organizational Implications, Introduction, Cost of Cybercrimes and IPR issues, Web threats for Organizations, Security and Privacy Implications, Social media marketing: Security Risks and Perils for Organizations, Social Computing and the associated challenges for Organizations.                                                                                                                                                                                                                                            | <b>08</b> |
| Module 4         | Introduction to Cyber Forensics: Network Forensics, Mobile Forensics, Photograph Forensics, Mac Forensics.                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>10</b> |
| Module 5         | Introduction to Cyber Laws, Cyber Laws in India and Case Studies. International Cyber Laws and Case Studies. Role of Cyber Security and Cyber Forensics in India.                                                                                                                                                                                                                                                                                                                                                                                  | <b>6</b>  |
|                  | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>42</b> |
| <b>Text</b>      | <ol style="list-style-type: none"> <li>1. Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Nina Godbole and Sunil Belapure, Wiley, 2011.</li> <li>2. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press, 2010.</li> <li>3. Dejeay, Murugan, Cyber Forensics, Oxford University Press, 2018.</li> </ol>                                                                                                                                                                        |           |
| <b>Reference</b> | <ol style="list-style-type: none"> <li>1. Chwan-Hwa Wu, J. David Irwin, Introduction to Computer Networks and Cyber Security, CRC Press, 2013.</li> <li>2. Marcella Jr., Albert, Doug Menendez, Cyber Forensics: A Field Manual for Collecting, Examining, and Preserving Evidence of Computer Crimes,</li> <li>3. Marc Goodman, Future Crimes: Inside the Digital Underground and the Battle for Our Connected World, Corgi, 2016.</li> <li>4. Darren R. Hayes, A Practical Guide to Computer Forensics Investigations, Pearson, 2014.</li> </ol> |           |

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Course name                       | L | T | P | C | Year            | Semester        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|---|---|---|---|-----------------|-----------------|
| CS476                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Introduction to Hardware Security | 3 | 1 | 0 | 4 | 4 <sup>th</sup> | 7 <sup>th</sup> |
| <p><b>Course Objective:</b> The goal of this course is to provide students with an overall understanding of the foundations for understanding hardware security and trust, which have become major concerns for international security over the past decade. Students will be familiar with security and trust issues in all types of electronic devices and systems such as ASICs, COTS, FPGAs, microprocessors/DSPs, and embedded systems. This serves as an invaluable reference to the state-of-the-art research that is of critical significance to the security of, and trust in, modern society's microelectronic-supported infrastructures. It will also enhance the students' ability to understand how to access schematic, layout and design files for a printed circuit board for hardware hacking</p> |                                   |   |   |   |   |                 |                 |

(i.e. the HaHa board) that can be used by instructors to fabricate boards, a suite of videos that demonstrate different hardware vulnerabilities, hardware attacks and countermeasures, and a detailed description and user manual for companion materials.

| Topic            | Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | No. of Lectures |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| Module 1         | Overview of Modern Cryptography, Hardware Design of Cryptographic Algorithms.                                                                                                                                                                                                                                                                                                                                                                                                            | 4               |
| Module 2         | Electronic Hardware (ASIC, FPGA, PCBs)- Background on Electronic Hardware, System-on-Chip (SOC) Design and Test, Printed Circuit Boards (PCBs) Design and Test.                                                                                                                                                                                                                                                                                                                          | 6               |
| Module 3         | Hardware Attacks: Analysis, Examples & Threat Models: Hardware Trojan Horse, Hardware Supply Chain Issues, Hardware IP Piracy and IP Reverse Engineering, Side-Channel Attacks (SCA), Scan-based Attacks, JTAG Hacks and DMA Attacks, IC Micro probing Attacks and IC Reverse Engineering. Attacks on PCB – Snooping, Counterfeiting, Reverse Engineering and Piracy, Physical Attacks. , Differential Fault Analysis of Ciphers, Cache Attacks on Ciphers.                              | 15              |
| Module 4         | Countermeasures Against Hardware Attacks- Hardware Security Primitives, Design for Security (DFS) and Security/Trust Validation for Integrated Circuits, Hardware Obfuscation, PCB Integrity Validation and Authentication.                                                                                                                                                                                                                                                              | 8               |
| Module 5         | Emerging Trends in Hardware Attacks and Protections- Joint Hardware-Software Attacks and Countermeasures, The Hardware Hacking (HaHa) Platform for Hands-on Training.                                                                                                                                                                                                                                                                                                                    | 7               |
|                  | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>40</b>       |
| <b>Text</b>      | <ol style="list-style-type: none"> <li>1. Swarup Bhunia, Mark Tehranipoor, Hardware Security: A Hands-on Learning Approach, Morgan Kaufmann, 2018.</li> <li>2. Mohammad Tehranipoor, Cliff Wang, Introduction to Hardware Security and Trust, Springer, 2014.</li> </ol>                                                                                                                                                                                                                 |                 |
| <b>Reference</b> | <ol style="list-style-type: none"> <li>1. Debdeep Mukhopadhyay, Rajat Subhra Chakraborty, Hardware Security: Design, Threats, and Safeguards, Chapman and Hall/CRC, 2014.</li> <li>2. Roger R. Dube, Hardware-based Computer Security Techniques to Defeat Hackers: From Biometrics to Quantum Cryptography, Wiley-Blackwell, 2008.</li> <li>3. Edgar Weippl, Christian Krieg, Adrian Dabrowski, Heidelinde Hobel, Hardware Malware, Morgan and Claypool Life Sciences, 2013.</li> </ol> |                 |

## Open Elective

### List of choices

| Course code           | Course Name                                | Department offering the course            |
|-----------------------|--------------------------------------------|-------------------------------------------|
| <a href="#">MA461</a> | Optimization Methods                       | Basic Science and Humanities              |
| <a href="#">MA462</a> | Scientific Computation                     | Basic Science and Humanities              |
| <a href="#">CS461</a> | Block Chain Technology                     | Computer Science and Engineering          |
| <a href="#">CS462</a> | Computational Intelligence                 | Computer Science and Engineering          |
| <a href="#">CS463</a> | Mobile Computing                           | Computer Science and Engineering          |
| <a href="#">CS464</a> | Software Reliability and Quality Assurance | Computer Science and Engineering          |
| <a href="#">CS465</a> | Introduction to Data Science               | Computer Science and Engineering          |
| <a href="#">EC461</a> | VLSI System Design                         | Electronics and Communication Engineering |
| <a href="#">EC462</a> | System on Chip                             | Electronics and Communication Engineering |
| <a href="#">EC463</a> | Speech and Audio Processing                | Electronics and Communication Engineering |
| <a href="#">ME461</a> | Quality Control.                           | Mechatronics Engineering                  |
| <a href="#">ME462</a> | Advanced Robotics.                         | Mechatronics Engineering                  |
| <a href="#">ME463</a> | Materials Characterizations Methods.       | Mechatronics Engineering                  |
| <a href="#">ME464</a> | Physics of Manufacturing Processes         | Mechatronics Engineering                  |
|                       | Biomedical Instrumentation                 | Electronics and Communication Engineering |

### Syllabus for Open Elective Courses

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Course name                                                                                                                                                                                                                                                                                                                                          | L | T | P | C | Year            | Semester        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|-----------------|-----------------|
| MA461                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Optimization Methods</b>                                                                                                                                                                                                                                                                                                                          | 3 | 1 | 0 | 4 | 4 <sup>th</sup> | 7 <sup>th</sup> |
| <b>Course objective:</b> Optimization is the process of obtaining the best result under given circumstances. In design, construction and maintenance of any engineering system, engineers have to take many technological and managerial decisions at several stages. The ultimate goal of all such decisions is either to minimize the effort required or to maximize the desired benefit. The objective is to introduce number of optimization methods developed for solving different types of optimization problem. |                                                                                                                                                                                                                                                                                                                                                      |   |   |   |   |                 |                 |
| Topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Contents                                                                                                                                                                                                                                                                                                                                             |   |   |   |   | No. of Lectures |                 |
| Module-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Introduction and Basic Concepts: Historical Development; Engineering applications of Optimization; Art of Modeling, Objective function; Constraints and Constraint surface; Formulation of design problems as mathematical programming problems, Classification of optimization problems, Optimization techniques –classical and advanced techniques |   |   |   |   | 08              |                 |

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |    |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Module-II  | Optimization using Calculus: Stationary points; Functions of single and two variables; Global Optimum, Convexity and concavity of functions of one and two variables, Optimization of function of one variable and multiple variables; Gradient vectors; Examples, Optimization of function of multiple variables subject to equality constraints; Lagrangian function Optimization of function of multiple variables subject to equality constraints; Hessian matrix formulation; Eigen values, Kuhn-Tucker Conditions; Examples.                                                      | 08 |
| Module-III | Linear Programming: .Standard form of linear programming(LP) problem; Canonical form of LP problem; Assumptions in LP Models; Elementary operations, Graphical method for two variable optimization problem; Examples, Motivation of simplex method, Simplex algorithm and construction of simplex tableau; Simplex criterion; Minimization versus maximization problems, Revised simplex method; Duality in LP; Primal-dual relations; Dual Simplex, method; Sensitivity or post optimality analysis, Other algorithms for solving LP problems –Karmarkar’s projective scaling method. | 08 |
| Module-IV  | Linear Programming Applications: Use of software for solving linear optimization problems using graphical and simplex methods, Examples for transportation, structural and other optimization problems.                                                                                                                                                                                                                                                                                                                                                                                 | 08 |
| Module-V   | Dynamic Programming: Sequential optimization; Representation of multi stage decision process; Types of multi stage decision problems; Concept of sub optimization and the principle of optimality, Recursive equations –Forward and backward recursions; Computational procedure in dynamic programming (DP), Discrete versus continuous dynamic programming; Multiple state variables; curse of dimensionality in DP.                                                                                                                                                                  | 08 |
| Total      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 40 |
| Text       | 1) S.S. Rao, "Engineering Optimization: Theory and Practice", New Age International P. Ltd., New Delhi, 2000.<br>2) H.A. Taha, "Operations Research: AnIntroduction", 5th Edition, Macmillan, New York,1992.                                                                                                                                                                                                                                                                                                                                                                            |    |
| Reference  | 1) K. Deb, "Optimization for Engineering Design-Algorithms and Examples", Prentice-Hall of India Pvt. Ltd., New Delhi, 1995                                                                                                                                                                                                                                                                                                                                                                                                                                                             |    |

| Course Code                                                                                                                                                  | Course name                                                                                                                                                                                                          | L               | T | P | C | Year            | Semester        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---|---|---|-----------------|-----------------|
| MA462                                                                                                                                                        | Scientific Computation                                                                                                                                                                                               | 3               | 0 | 2 | 4 | 3 <sup>rd</sup> | 6 <sup>th</sup> |
| <b>Course objective:</b> The course provides an overview of the foundations of techniques needed to solve a differential equation in engineering disciplines |                                                                                                                                                                                                                      |                 |   |   |   |                 |                 |
| Topic                                                                                                                                                        | Contents                                                                                                                                                                                                             | No. of Lectures |   |   |   |                 |                 |
| <u>Module-I</u>                                                                                                                                              | Errors; Iterative methods for nonlinear equations; Polynomial interpolation, spline interpolations; Numerical integration based on interpolation, quadrature methods, Gaussian quadrature                            | 08              |   |   |   |                 |                 |
| <u>Module-II</u>                                                                                                                                             | Initial value problems for ordinary differential equations - Euler method, Runge-Kutta methods, multi-step methods, predictor-corrector method, stability and convergence analysis;                                  | 08              |   |   |   |                 |                 |
| <u>Module-III</u>                                                                                                                                            | Finite difference schemes for partial differential equations - Explicit and implicit schemes                                                                                                                         | 09              |   |   |   |                 |                 |
| <u>Module-IV</u>                                                                                                                                             | Consistency, stability and convergence; Stability analysis (matrix method and von Neumann method), Lax equivalence theorem                                                                                           | 08              |   |   |   |                 |                 |
| <u>Module-V</u>                                                                                                                                              | Finite difference schemes for initial and boundary value problems (FTCS, Backward Euler and Crank-Nicolson schemes, ADI methods, Lax Wendroff method, upwind scheme).                                                | 09              |   |   |   |                 |                 |
| <b>Total</b>                                                                                                                                                 |                                                                                                                                                                                                                      |                 |   |   |   |                 | <b>42</b>       |
| <b>Text</b>                                                                                                                                                  | 1. D. Kincaid and W. Cheney, Numerical Analysis: Mathematics of Scientific Computing, 3rd Ed., AMS, 2002.<br>2. G. D. Smith, Numerical Solutions of Partial Differential Equations, 3rd Ed., Calrendorn Press, 1985. |                 |   |   |   |                 |                 |
| <b>References</b>                                                                                                                                            | 1. K. E. Atkinson, An Introduction to Numerical Analysis, Wiley, 1989.<br>2. S. D. Conte and C. de Boor, Elementary Numerical Analysis - An Algorithmic Approach, McGraw-Hill, 1981.                                 |                 |   |   |   |                 |                 |

| Course Code                                                                                                                                                                                                                                                                           | Course name                                                                                                                                                                                                               | L               | T | P | C | Year            | Semester        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---|---|---|-----------------|-----------------|
| CS461                                                                                                                                                                                                                                                                                 | Blockchain Technology                                                                                                                                                                                                     | 3               | 1 | 0 | 4 | 4 <sup>th</sup> | 7 <sup>th</sup> |
| <b>Course Objective:</b> The objective of this course is to study the fundamentals of Blockchain technology. The students learn about the issues and challenges in cryptocurrency, abstract models of Blockchain, cryptocurrency mining, and mathematical analysis of cryptocurrency. |                                                                                                                                                                                                                           |                 |   |   |   |                 |                 |
| Topic                                                                                                                                                                                                                                                                                 | Contents                                                                                                                                                                                                                  | No. of Lectures |   |   |   |                 |                 |
| Module 1                                                                                                                                                                                                                                                                              | Introduction to Distributed Systems; Fault-Tolerance and Paxos, Consensus & Byzantine Agreement; Authenticated Agreement                                                                                                  | 7               |   |   |   |                 |                 |
| Module 2                                                                                                                                                                                                                                                                              | Block Chain Models, PoW, PoS, PoA, Hybrid Models, Introduction to Cryptography and Cryptocurrencies, Cryptographic Hash Functions, Digital Signatures, Encryption Public Keys as Identities, Elliptic Curve Cryptography. | 9               |   |   |   |                 |                 |



|                        |                                                                                                                                                                                                                                                                                            |           |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| Module 3               | Bitcoin: Bitcoin Merkle Tree, Bitcoin Mining Difficulty, Transaction Verifiability, Anonymity, Forks, Bitcoin Double Spending, Mathematical Analysis of Bitcoin                                                                                                                            | 7         |
| Module 4               | Applications: Ethereum Blockchain,, Ethereum Virtual Machine ( EVM), Smart Contract                                                                                                                                                                                                        | 6         |
| Module 5               | Study of Recent Trends and Research Topics in Blockchain Protocols, Zero-Knowledge Succinct Non-Interactive Argument of Knowledge,                                                                                                                                                         | 6         |
|                        | <b>Total</b>                                                                                                                                                                                                                                                                               | <b>35</b> |
|                        |                                                                                                                                                                                                                                                                                            |           |
| <b>Text Books</b>      | <ol style="list-style-type: none"> <li>1. Roger Wattenhofer, The Science of the Blockchain, 2017</li> <li>2. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Bitcoin and cryptocurrency technologies: a comprehensive introduction, 2016.</li> </ol> |           |
| <b>Reference Books</b> | <ol style="list-style-type: none"> <li>1. Melanie Swan, Blockchain, 2015.</li> <li>2. Sukumar Ghosh, Distributed Systems: An Algorithmic Approach, 2014.</li> </ol>                                                                                                                        |           |

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Course name                                                                                                                                                                                                                                                                                                                                                | L | T | P | C | Year            | Semester        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|-----------------|-----------------|
| CS462                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Computational Intelligence                                                                                                                                                                                                                                                                                                                                 | 3 | 1 | 0 | 4 | 4 <sup>th</sup> | 7 <sup>th</sup> |
| <p>Course objective: This course is designed for those who are interested in designing and developing intelligent systems and/or are about to start research in computational intelligence. The course will focus on the main CI approaches and methodologies, namely artificial neural networks, genetic algorithms, swarm optimization, and fuzzy systems. The course is a research-based course and therefore focuses on leading students to investigate the current state of research in CI areas as well as to gain comprehensive theoretical knowledge from scientific research about the basic concepts and features of CI methodologies and approaches.</p> |                                                                                                                                                                                                                                                                                                                                                            |   |   |   |   |                 |                 |
| Topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Contents                                                                                                                                                                                                                                                                                                                                                   |   |   |   |   | No. of Lectures |                 |
| Module-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Introduction to soft computing : Soft computing constituents and conventional Artificial intelligence, soft computing characteristics.                                                                                                                                                                                                                     |   |   |   |   | 06              |                 |
| Module-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Fuzzy Sets, Fuzzy Rules and Fuzzy reasoning : Introduction, Basic definitions and terminology; Set theory operations : Fuzzy union, Intersection and Complement, Extension principal and fuzzy relations, Fuzzy IF rules, MF formulation and parameterization; Fuzzy inference System : Mamdani fuzzy models, Sugeno fuzzy models, Tsukamoto fuzzy models. |   |   |   |   | 09              |                 |

|            |                                                                                                                                                                                                                                    |    |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Module-III | Artificial Neural Network : Supervised Learning Neural Network, Preceptron, Adaline, multi-layer neural networks, back propagation algorithm, Radial basis function networks.                                                      | 08 |
| Module-IV  | Functional Link Artificial Neural network : update algorithms, trigonometric and power series expansions; Unsupervised Learning Neural Network : Competitive learning networks, Kohonen self-organizing networks, Hopfield network | 08 |
| Module-V   | Introduction to Neuro Fuzzy Networks : Genetic Algorithm, Adaptive Genetic Algorithm, Ant Colony Algorithm, Bacteria Foraging Algorithm, Particle Swarm Optimization; Introduction to other soft computing technique.              | 09 |
| Total      |                                                                                                                                                                                                                                    | 40 |
| Text       | 1. J.S.R. Jng, C.T.Sun and E.Mizutani, <i>Neuro-Fuzzy and soft Computing</i> , PHI, 2009.<br>2. Simon Haykin, <i>Neural Networks-A Comprehensive foundation</i> , Pearson Education India, 2012.                                   |    |
| Reference  | 1. G.A. Vijayalaksmi, <i>Neural Networks, Fuzzy Logic and Genetic Algorithm</i> , PHI, 2000.                                                                                                                                       |    |

| Course Code                                                                                                                                                                                                                                                                                                                                              | Course name                                                                                                                                   | L               | T | P | C | Year            | Semester        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---|---|---|-----------------|-----------------|
| CS463                                                                                                                                                                                                                                                                                                                                                    | Mobile Computing                                                                                                                              | 3               | 1 | 0 | 4 | 4 <sup>th</sup> | 7 <sup>th</sup> |
| <b>Course Objective:</b> The objective of this course is to give an overview of fundamentals of Mobile Computing Principles. The students learn about issues in cellular communication architecture such as 2G, 3G, and 4G, mobile ad-hoc networks, mobile IP issues. The students learn in brief the recent research topics such as 5G and IoT systems. |                                                                                                                                               |                 |   |   |   |                 |                 |
| Topic                                                                                                                                                                                                                                                                                                                                                    | Contents                                                                                                                                      | No. of Lectures |   |   |   |                 |                 |
| Module 1                                                                                                                                                                                                                                                                                                                                                 | Mobile Communications an Overview, Mobile Computing Architecture, Mobile Devices and Systems                                                  | 6               |   |   |   |                 |                 |
| Module 2                                                                                                                                                                                                                                                                                                                                                 | GSM and 2G Architectures, Wireless MAC, 3G, 4G Communication, Mobile Satellite Communication Networks                                         | 8               |   |   |   |                 |                 |
| Module 3                                                                                                                                                                                                                                                                                                                                                 | Mobile IP Network Layer, Packet Delivery and Handover Management, Location Management, Mobile Transport Layer, Databases and Mobile Computing | 8               |   |   |   |                 |                 |
| Module 4                                                                                                                                                                                                                                                                                                                                                 | Data Dissemination and systems for Broadcasting, Data Synchronization in Mobile Computing Systems                                             | 7               |   |   |   |                 |                 |
| Module 5                                                                                                                                                                                                                                                                                                                                                 | Mobile Applications, Wireless LAN, Mobile Ad-Hoc and Sensor Networks, 5G Communications, Internet of Things.                                  | 6               |   |   |   |                 |                 |
|                                                                                                                                                                                                                                                                                                                                                          | <b>Total</b>                                                                                                                                  | <b>35</b>       |   |   |   |                 |                 |

|                        |                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Text Books</b>      | <ol style="list-style-type: none"> <li>1. Raj Kamal, Mobile Computing, 2014</li> <li>2. Jochen Schiller, Mobile Communications, 2003.</li> </ol>                                                                                                                                                                                                                                                         |
| <b>Reference Books</b> | <ol style="list-style-type: none"> <li>1. William Stallings, Wireless Communications and Networks, 2002.</li> <li>2. Kaveh Pahlavan, Prasanth Krishnamoorthy, Principles of Wireless Networks, 2003.</li> <li>3. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, Principles of Mobile Computing, 2007.</li> <li>4. Hazysztof Wesolowski, Mobile Communication Systems, 2002.</li> </ol> |

| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Course name                                                                                                                                                                                                                                                                                                                                             | L               | T | P | C | Year            | Semester        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---|---|---|-----------------|-----------------|
| CS464                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Software Reliability and Quality Assurance</b>                                                                                                                                                                                                                                                                                                       | 3               | 1 | 0 | 4 | 4 <sup>th</sup> | 7 <sup>th</sup> |
| <p><b>Course Objective:</b> The goal of this course is to provide students with an overall understanding of basic concepts in the formulation, application, and evaluation of software reliability engineering and quality assurance techniques in practice. The course is designed for researchers and students in software engineering, reliability analysis, operations research, and related disciplines, and anyone who wants a deeper understanding of software reliability and its engineering techniques. It will also enhance the students with the state of the art techniques, methodologies, tools, best practices and guidelines for software quality assurance and offers guidance for future software engineering research and practice.</p> |                                                                                                                                                                                                                                                                                                                                                         |                 |   |   |   |                 |                 |
| Topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Contents                                                                                                                                                                                                                                                                                                                                                | No. of Lectures |   |   |   |                 |                 |
| Module 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Introduction to Software Reliability Engineering: Software Reliability and System Reliability, Software Reliability Modelling Survey, Techniques for Prediction Analysis and Recalibration, Current Practice of SRE.                                                                                                                                    | 5               |   |   |   |                 |                 |
| Module 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Software Reliability Measurement: Measurement-Based Analysis of Software Reliability, Orthogonal Defect Classification, Trend Analysis, Field Data Analysis, Software Metrics for Reliability Assessment.                                                                                                                                               | 10              |   |   |   |                 |                 |
| Module 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Software Testing and Reliability: Verification and Validation, Role of Formal Methods, Role of Testing and Automated Testing, Fault-Tolerant Software Reliability Engineering, Software System Analysis Using Fault Trees, Software Reliability Simulation.                                                                                             | 10              |   |   |   |                 |                 |
| Module 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Introduction to Modern Software Quality Assurance (SQA): Software Quality Management, Software Quality Models, Addressing System Qualities, Assessing System Qualities, Current Challenges and Future Directions of Software Quality, Defect Analysis and Process Improvement, Role of Product and Process Metrics, Statistical SQA, Change Management. | 10              |   |   |   |                 |                 |







| Topic                             | Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | No. of Lectures |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| <a href="#"><u>Module-I</u></a>   | Introduction: Production and transmission of acoustic signals: articulation of human speech. Acoustic- phonetic structure of Speech and Music: music synthesis and speech synthesis. A history of Voders & Vocoders and early speech recognition methods. Acoustic-Phonetic classification: Phonemes, Auto-spectra. Short-term Spectral Analysis and STFT, the ARPA and DARPA projects, Pattern matching, introduction to Hidden Markov (HMM) Models. Adaptive segmentation of speech | 09              |
| <a href="#"><u>Module-II</u></a>  | The stochastic parameters of human speech, Gaussian densities and statistical model training, voiced and unvoiced speech, voice-box modelling, resonance. Acoustic travelling waves. Psycho-acoustics, Physiological exploration of periodicity, audio-spectrograms and sonograms, pitch-perception models                                                                                                                                                                            | 09              |
| <a href="#"><u>Module-III</u></a> | Physiology of the ear and hearing mechanism, the Auditory System modelled as a Filter-bank, Gamma-tone and Roex filters, Spectrum and Complex Cepstrum analysis of speech as perceived by detectors, Automatic Speech Recognition (ASR), Linear Prediction analysis                                                                                                                                                                                                                   | 08              |
| <a href="#"><u>Module-IV</u></a>  | Phonetic and phonemic alphabets, phonological models of ASR, Linear and Dynamic Time-warping, connected word recognition, Statistical sequence recognition and model training in speech pattern recognition, HMM training, Viterbi training, MLP training                                                                                                                                                                                                                             | 08              |
| <a href="#"><u>Module-V</u></a>   | Speech Synthesis and coding, Formant synthesizers, Vocoders, Speech transformation, Speaker verification, Music synthesizers, speech-assisted applications in industry, defence and medicine                                                                                                                                                                                                                                                                                          | 08              |
| <b>Total</b>                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>42</b>       |
| <b>Text</b>                       | 1. L. R. Biing-Hwang Juang, <i>Fundamentals of Speech Recognition</i> , Pearson Education, 2003.<br>2. D. Jurafsky and J. H. Martin, <i>Speech and Language Processing-An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition</i> , Pearson Education                                                                                                                                                                                      |                 |
| <b>Reference:</b>                 | 1. Thomas F Quatieri, <i>Discrete-Time Speech Signal Processing-Principles and Practice</i> , Pearson Education.<br>2. Steven W. Smith, <i>The Scientist and Engineer's Guide to Digital Signal Processing</i> , California Technical Publishing.                                                                                                                                                                                                                                     |                 |

| Course Code                                                                                                                                                                                                                                                                                                                                                                                 | Course name     | L | T | P | C | Year            | Semester               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---|---|---|---|-----------------|------------------------|
| ME461                                                                                                                                                                                                                                                                                                                                                                                       | Quality Control | 3 | 1 | 0 | 4 | 4 <sup>th</sup> | 7 <sup>th</sup>        |
| <b>Course objective:</b> <ol style="list-style-type: none"> <li>1. To understand the philosophy and basic concepts of quality improvement in industry or organization.</li> <li>2. To understand the quality control in specified limit.</li> <li>3. To understand the principle of acceptance of sample.</li> <li>4. To understand the defect diagnosis process of the samples.</li> </ol> |                 |   |   |   |   |                 |                        |
|                                                                                                                                                                                                                                                                                                                                                                                             |                 |   |   |   |   |                 |                        |
| <b>Contents</b>                                                                                                                                                                                                                                                                                                                                                                             |                 |   |   |   |   |                 | <b>No. of Lectures</b> |
| <b>Module 1</b>                                                                                                                                                                                                                                                                                                                                                                             |                 |   |   |   |   |                 |                        |





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| <b>CONTROL SYSTEMS AND COMPONENTS:</b> Basic Control Systems Concepts and Models, Controllers, Control System Analysis, Robot Activation and Feedback Components, Power Transmission Systems, Robot Joint Control Design.<br><b>ROBOT END EFFECTORS:</b> Types, Mechanical Grippers and Other types, Tools as End Effectors, The Robot/End Effector Interface, Considerations in Gripper Selection and Design | <b>8</b>  |
| <b>Module 2</b>                                                                                                                                                                                                                                                                                                                                                                                               |           |
| <b>MACHINE VISION:</b> Introduction, The Sensing and Digitizing function, Image processing and Analysis, Training and Vision Systems, Robotic Applications.                                                                                                                                                                                                                                                   | <b>8</b>  |
| <b>Module 3</b>                                                                                                                                                                                                                                                                                                                                                                                               |           |
| <b>ROBOT PROGRAMMING:</b> Programming methods, Robot program as a path in space, Motion Interpolation, WAIT, SIGNAL, DELAY Commands, Branching                                                                                                                                                                                                                                                                | <b>8</b>  |
| <b>Module 4</b>                                                                                                                                                                                                                                                                                                                                                                                               |           |
| <b>ROBOT LANGUAGES :</b> The Textual Robot languages, Generations of Robot programming languages, Robot language Structures, Constants, Variables, and other data Objects, Motion Commands, program Control and Subroutines                                                                                                                                                                                   | <b>10</b> |
| <b>Module 5</b>                                                                                                                                                                                                                                                                                                                                                                                               |           |
| <b>ROBOT APPLICATIONS IN MANUFACTURING:</b> Material Transfer And Machine Loading / Unloading, An Approach for Implementing Robotics<br><b>FUTURE APPLICATIONS:</b> Characteristics of Future Robot Tasks, Future manufacturing Applications, Hazardous and Inaccessible Nonmanufacturing Environments                                                                                                        | <b>8</b>  |
| <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                                                  | <b>42</b> |
| <b>Text</b><br><br>1. Mikell P. Groover , Mitchell Weiss , Roger N. Nagel , Nicholas G. Odrey Industrial Robotics: Technology, Programming, and Applications , 1st edition, McGraw-Hill International Edition, 1986<br>2. K.S.Fu, R.C Gonzalez, C.S.G.Lee , ROBOTICS , Control, Sensing , Vision and Intelligence , 1st edition, McGraw-Hill International Edition, 1987                                      |           |

| Course Code                                                                                   | Course name                       | L | T | P | C | Year            | Semester        |
|-----------------------------------------------------------------------------------------------|-----------------------------------|---|---|---|---|-----------------|-----------------|
| ME463                                                                                         | Material Characterization Methods | 3 | 1 | 0 | 4 | 4 <sup>th</sup> | 7 <sup>th</sup> |
| <b>Course objective:</b><br><br>1. Introduce basic techniques for materials characterization. |                                   |   |   |   |   |                 |                 |

| 2. Introduce the working principles and instrumentation of main techniques.<br>3. Introduce the interpretation of the characterization technique outputs.<br>4. Observe operations of characterization equipment.               |                                                                                                                                             |                 |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
|                                                                                                                                                                                                                                 |                                                                                                                                             |                 |
| Topics                                                                                                                                                                                                                          | Contents                                                                                                                                    | No. of Lectures |
| <b>Module : 1</b>                                                                                                                                                                                                               |                                                                                                                                             |                 |
| Elements of Crystallography, Principles of X-ray diffraction, X-ray equipment and data analysis; associated techniques in X-ray spectroscopy, Fundamentals of elemental analysis.                                               |                                                                                                                                             | <b>10</b>       |
| <b>Module : 2</b>                                                                                                                                                                                                               |                                                                                                                                             |                 |
| Optical/Electron Microscopy Techniques, Specimen preparation techniques for optical and electron microscopy in metallurgy. Elements of phase identification, grain size determination, inclusion analysis, Image analysis, etc. |                                                                                                                                             | <b>10</b>       |
| <b>Module : 3</b>                                                                                                                                                                                                               |                                                                                                                                             |                 |
| Electron diffraction, SEM, Failure analysis and fractography, EDAX / EPMA, data analysis. Neutron Scattering Techniques: Diffraction, inelastic scattering and reflectometry.                                                   |                                                                                                                                             | <b>10</b>       |
| <b>Module : 4</b>                                                                                                                                                                                                               |                                                                                                                                             |                 |
| Thermal Analysis: Principles and applications of thermal analysis; DTA, DSC, TGA, TMA, DMA, etc.                                                                                                                                |                                                                                                                                             | <b>8</b>        |
| <b>Module : 5</b>                                                                                                                                                                                                               |                                                                                                                                             |                 |
| Mechanical Property characterization, Principles and characterisation techniques related to Tensile, compressive, hardness, fatigue and fracture toughness properties. Deformation; Superplasticity                             |                                                                                                                                             | <b>10</b>       |
|                                                                                                                                                                                                                                 | <b>Total</b>                                                                                                                                | <b>48</b>       |
|                                                                                                                                                                                                                                 |                                                                                                                                             |                 |
| <b>Text</b>                                                                                                                                                                                                                     | 1. “Materials characterization”, Vol. 10, ASM hand book, 1997.<br>2. B. D. Cullitey, “Elements of X-ray diffraction”, Addison-Wesely, 1968. |                 |
| <b>Reference</b>                                                                                                                                                                                                                | 1. ASTM handbook, vol. 3, 1997.<br>2. R. F. Speyer, “Thermal Analysis of Materials”, Marcel Decker, 1994                                    |                 |

| Course Code                                                                                                                                                                                                                                                                                      | Course name                        | L | T | P | C | Year            | Semester        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|---|---|---|---|-----------------|-----------------|
| ME464                                                                                                                                                                                                                                                                                            | Physics of Manufacturing Processes | 3 | 1 | 0 | 4 | 4 <sup>th</sup> | 7 <sup>th</sup> |
| <b>Course objective:</b><br>1. This course gives an introduction to production methods and manufacturing technologies used in engineering.<br>2. The focus is given on the understanding of physical phenomena underlying the processes, the relation between materials/manufacturing processes. |                                    |   |   |   |   |                 |                 |
|                                                                                                                                                                                                                                                                                                  |                                    |   |   |   |   |                 |                 |
| Topics                                                                                                                                                                                                                                                                                           | Contents                           |   |   |   |   |                 | No. of Lectures |
| <b>Module : 1</b>                                                                                                                                                                                                                                                                                |                                    |   |   |   |   |                 |                 |
| Stress and strain behavior of materials, plastic and tangent modulus, work hardening, plastic instability in tensile test, empirical stress-strain equations, effect of pressure, strain-rate and temperature.                                                                                   |                                    |   |   |   |   | 8               |                 |
| <b>Module : 2</b>                                                                                                                                                                                                                                                                                |                                    |   |   |   |   |                 |                 |
| Analysis of stress tensor, eigenvalues, decomposition into deviatoric and hydrostatic components, octahedral stresses, analysis of strain and strain rates, stress equilibrium and virtual work, objective stress rates.                                                                         |                                    |   |   |   |   | 8               |                 |
| <b>Module : 3</b>                                                                                                                                                                                                                                                                                |                                    |   |   |   |   |                 |                 |
| Plasticity: the criteria of yielding, isotropic and anisotropic hardening, rules of plastic flow, Levy-Mises and Prandtl-Reuss equations, anisotropic flow rule, Hill's 1948 and 1979 yield criteria for anisotropic yielding.                                                                   |                                    |   |   |   |   | 8               |                 |
| <b>Module : 4</b>                                                                                                                                                                                                                                                                                |                                    |   |   |   |   |                 |                 |
| Upper bound theorem and its application in deformation processes like rolling, wire drawing, extrusion, forging. Lower bound theorem with a few applications. Slab method and its application in deformation process like symmetric/asymmetric rolling, forging, wire drawing and extrusion.     |                                    |   |   |   |   | 8               |                 |
| <b>Module : 5</b>                                                                                                                                                                                                                                                                                |                                    |   |   |   |   |                 |                 |
| Elastoplastic sheet bending. Analysis of autofrettage. Theory of slip line field and its application in metal forming. Heat transfer analysis in deformation processes with examples from rolling and friction stir welding/processing. Workability and dynamic materials model.                 |                                    |   |   |   |   | 8               |                 |
|                                                                                                                                                                                                                                                                                                  |                                    |   |   |   |   | <b>Total</b>    | <b>40</b>       |

|                  |                                                                                                                                                                                                                                                                                                                                                 |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Text</b>      | <ol style="list-style-type: none"> <li>1. J. Chakrabarty, “Theory of plasticity”, Elsevier Butterworth-Heinemann Company, Singapore, 2006.</li> <li>2. B. L. Juneja, “Fundamentals of metal forming processes”, New Age International, New Delhi, 2007.</li> </ol>                                                                              |
| <b>Reference</b> | <ol style="list-style-type: none"> <li>1. P. M. Dixit and U. S. Dixit, “Modelling of Metal Forming and Machining Processes: By Finite Element and Soft Computing Methods”, Springer, London, 2008.</li> <li>2. W. F. Hosford and R. M. Caddell, “Metal forming: mechanics and metallurgy”, Cambridge University Press, London, 2011.</li> </ol> |