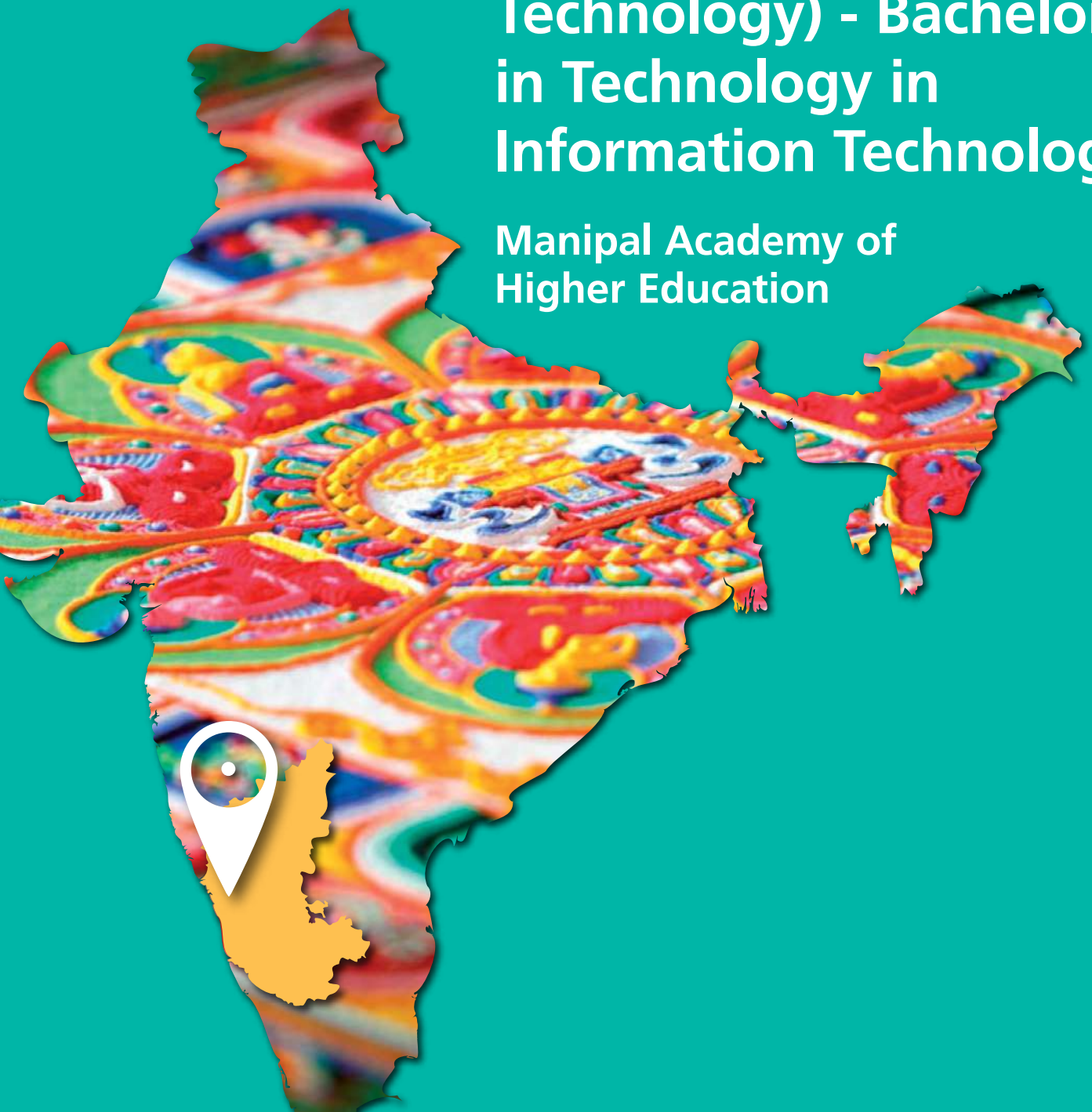
# Tuning

India

# Degree Programme B. Tech (Information Technology) - Bachelor in Technology in Information Technology

## Manipal Academy of Higher Education



**Degree Programmes B. Tech (Information Technology) - Bachelor in Technology in Information Technology. Manipal Academy of Higher Education**

The degree programme deals with the length, level and definition of the programme in terms of competences and learning outcomes; it also analyses the methodologies for developing the appropriate strategy of teaching, learning and assessing those competences as well as setting up the internal systems for assuring programme quality.

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# Contents

# 1

# Name and level of the programme

## B.Tech (Information Technology) – Bachelor in Technology in Information Technology

A student passed in 10+2, A-Level, IB, American 12th grade or equivalent with Physics, Mathematics and English as compulsory subjects along with Chemistry or Biotechnology or Biology or any technical vocational subjects as optional with a minimum of 50% marks taken together in Physics, Mathematics and any one of the optional subjects is eligible for admission to B.Tech (Information Technology) subjected to clearing the University entrance examination. The B.Tech in Information Technology is a four-year undergraduate programme, which caters to the needs of the IT industry from across the world. Graduates of these programmes are eligible to apply for higher studies to pursue an MS or PhD in their chosen field of interest.

# 2

# The social need for the programme (in its revised version)

The development of technology has changed the business operations and functions. This results in a need for IT professionals across the globe, who is expert in cutting edge technologies. The programme is designed with the aim of producing qualified IT professionals who is expert in providing solutions to business requirement.

The technology is changing day by day and today's technology may be obsolete for tomorrow. This results in a need for revising the courses in the programme. The curriculum conclave is conducted every 4 years where the students presents their dream syllabus and also the feedback is taken from the alumni and employers. Based on the feedback received, the final syllabus of the programme is revised, which is approved by the board of studies and Academic Council.

Currently we are undertaking the bridging exercise to the course Principles of Data Communication. This subject is taught to the 3rd semester (Section B) Information Technology program. Data communication is one of the fastest growing technologies and applications based on this technology is adapted in various domain, mainly in telecommunication and computer communication. Number of job opportunity in this domain is being increased drastically in recent years. This results in need for understanding fundamentals of data communications for IT graduates for success in their carrier. Principles of data communication is included as one of the core course in IT program. The rationale for considering this subject is that we are taking this subject on the pilot basis to incorporate this study exercise. We will be consider taking up other subjects as well to bridge the gap as suggested by the Tuning India meta-profile and the current profile of the program in a phased manner.

# 3

# Future fields, sectors of employment/occupation of graduates

During the counselling process at the time of admission the counsellors provide the information about a wide variety of career scopes are available to graduates at Government, Private, Defense, Semi-Government sectors; there are also entrepreneurial opportunities. The most of the programme graduates get employment in private software organizations from across the world under the following positions:

| | |
|---|---|
| 1 | Software Engineer |
| 2 | IT Consultant |
| 3 | Software Developer |
| 4 | Software Tester |
| 5 | Software Architects |

Note that these designations and nomenclature vary from company to company.

The Placement cell will provide information about carrier opportunities like Computer Programmers, Data Scientists, Web Developers, Network Engineers, App developers, Server Security Managers, Multi Media, Entertainment Industry, Machine Translator, Database Administrator, Software Testing, Medical Transcriptors, E-governance etc.

# 4

# Description of the degree profile of the new programme or a revised programme in terms of generic and subject-specific competences. Definition of competences and formulation of learning outcomes at programme level

**Table 4.2.1**

Specific Competencies of Information Technology

| | |
|---|---|
| S1 | Consider mathematical principles, algorithms and computer sciences to understand and solve problems |
| S5 | Design of ICT systems, including modelling (formal description) of their structure and processes |
| S6 | Deploy, install, integrate, put into service and maintain ICT systems and their elements |
| S8 | Develop ICT systems in compliance with industry specifications, standards and recommendations |
| S11 | Identify security threats and provide effective methods for information security |
| S12 | Understanding and applying ethical, legal, economic and financial concepts in order to take decisions and manage ICT projects |

**Table 4.2.2**

Generic Competencies of Information Technology

| | |
|---|---|
| G1 | Find and interpret relevant information for a given problem |
| G4 | Apply knowledge in practical situations |
| G6 | Thinking and learning to learn for the autonomous development |
| G9 | Establish meaningful relationships in working contexts |
| G14 | Communicate effectively orally and in writing |
| G15 | Work in teams collaboratively to solve given problems |
| G21 | Consider and adapt the work to emerging trends |
| G26 | Use available resources optimally and efficiently |
| G28 | Use organizational and managerial skills in remote and collaborative contexts |

**Table 4.5**

Program Outcome (PO)s

| | |
|---|---|
| PO1 | **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems |
| PO2 | **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences |
| PO3 | **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations |
| PO4 | **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions |
| PO5 | **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations |
| PO6 | **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice |
| PO7 | **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development |
| PO8 | **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice |
| PO9 | **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings |
| PO10 | **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions |
| PO11 | **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments |
| PO12 | **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change |
| PSO1 | To identify, analyze and develop software systems using appropriate techniques and concepts related to information technology |
| PSO2 | To design an algorithm or process within realistic constraints to meet the desired needs through analytical, logical and problem-solving skills |
| PSO3 | To apply state of the art IT tools and technologies, IT infrastructure management abilities in treading innovative career path as a prospective IT engineer |

Programme-level learning outcomes are measured using Course Outcomes (CO)s, where COs are measured using different components like quizzes, sessional tests and end semester examinations.

| Competence/ Dimensions of Meta-profile | Generic or Subject-Specific? | Definition of the competence – how is it understood in your programme? | Programme-Level Learning Outcomes (minimum 1 - maximum 3 per competence) |
|---|---|---|---|
| 1. **Knowledge & Theoretical Concepts -** Acquisition of relevant principles, concepts & methods from mathematics, Computer Science, statistics and other allied disciplines and their applications to develop research capabilities. | S1 G1 | Apply knowledge of mathematical and computer science principles to solve complex engineering problems. | (PO1) Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. |
| 2. **Analysis, Problem Solving & Design –** Developing the ability to apply the knowledge already acquired to formulate, analyze and model the solution for practical problems in an innovative manner. It should involve utilization of the available resources optimally so that the target is achieved in a secured manner, being also complaint with standards and specification. | S5, S11<br>G4, G26 | Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. | (PO2) Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.<br>(PO4) Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.<br>(P05) Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.<br>(PSO2) To design an algorithm or process within realistic constraints to meet the desired needs through analytical, logical and problem-solving skills |
| 3. **Development, Deployment & Maintenance –** Acquire knowledge with an understanding of various tools of written and oral communication and demonstrate effective and unambiguous communication capabilities at different stages of ICT project including training and support for ICT users that simultaneously respects and appreciates diversity and multiculturalism. | S6, S8 | Design solutions for complex engineering problems in compliance with industry specifications, standards considering the public health and safety, and the cultural, societal, and environmental considerations. | (PO3**)** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.<br>(PSO1) To identify, analyze and develop software systems using appropriate techniques and concepts related to information technology.<br>(PSO3) To apply state of the art IT tools and technologies, IT infrastructure management abilities in treading innovative career path as a prospective IT engineer |

| Competence/ Dimensions of Meta-profile | Generic or Subject-Specific? | Definition of the competence – how is it understood in your programme? | Programme-Level Learning Outcomes (minimum 1 - maximum 3 per competence) |
|---|---|---|---|
| 4. **Interpersonal skills –** Develop interpersonal skills to optimize performance in various areas like quality assurance, documentation, security, decision making, self help, confidence building, entrepreneurial spirit, leadership qualities, managerial skills, stress management, and goal oriented approach. | G9, G15, G28, G14 | Function effectively in a team to take reasoned decisions and appreciate and respect diversity and multiculturism | (PO10) Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.<br>(PO9) Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.<br>(PO11) Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments |
| 5. **Professional Ethics & Societal Responsibilities –** To learn and appreciate professional ethics and social responsibilities so that ICT solutions follow data safety and confidentiality norms, are assimilated to socio-culturaleOonvironmental needs, apply ethical, legal, financial concepts to decision making, crisis management, self help and provide equal opportunities and gender equality. | S12 | Apply ethical principles and commit to professional ethics and responsibilities so that ICT solutions follow data safety and confidentiality norms | (PO8) Apply ethical principles and commit to professional ethics and responsibilitieand norms of the engineering practice.<br>(PO6) Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.<br>(PO7) Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. |
| 6. **Lifelong learning –** To continue education and training throughout life, with the aim of improving knowledge, skills and competences within a personal, civic, social and/or employment-related perspective | G6, G21 | Be goal-oriented and recognize the need for, and have the preparation and ability to engage in life-long learning in the broadest context of technological change. | (PO12) Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. |

# 5

# Link of the competences with the agreed meta-profile

All elements of the degree profile are the part of meta-profile. The comparison with the meta profile is given below.

**Table 5.1**
Course Mapping with Competancies

| Competencies | Description of Meta Profile | Courses |
|---|---|---|
| S1: Consider mathematical principles, algorithms and computer sciences to understand and solve problems.,<br>G1: Find and interpret relevant information for a given problem | Apply knowledge of mathematical and computer science principles to solve complex engineering problems. | • Mathematics - III<br>• Digital Systems<br>• Mathematics - IV<br>• Principles of Data Communication<br>• Computer Network Protocols<br>• Computer Organization and Microprocessor Systems<br>• Design and Analysis of Algorithms'<br>• Operating Systems<br>• Microprocessor Systems Lab<br>• Operating Systems Lab<br>• Cyber Security<br>• Database Systems<br>• Embedded Systems<br>• Software Engineering<br>• Embedded Systems Lab<br>• Data Warehousing and Data Mining<br>• Distributed Systems |

| Competencies | Description of Meta Profile | Courses |
|---|---|---|
| S5: Design of ICT systems, including modelling (formal description) of their structure and processes,<br>S11: Identify security threats and provide effective methods for information security,<br>G4: Apply knowledge in practical situations,<br>G26: Use available resources optimally and efficiently | Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. | • Data Structures<br>• Digital Systems<br>• Object Oriented Programming<br>• Principles of Data Communication<br>• Digital Systems Lab<br>• Computer Network Protocols<br>• Computer Organization and Microprocessor Systems<br>• Design and Analysis of Algorithms'<br>• Operating Systems<br>• Microprocessor Systems Lab<br>• Cyber Security<br>• Database Systems<br>• Embedded Systems<br>• Software Engineering<br>• Embedded Systems Lab<br>• Network Programming and Simulation Lab<br>• Engg. Economics and Financial Management<br>• Data Warehousing and Data Mining<br>• Data Warehousing and Data Mining Lab<br>• Project Work / Practice School |
| S6: Deploy, install, integrate, put into service and maintain ICT systems and their elements,<br>S8: Develop ICT systems in compliance with industry specifications, standards and recommendations. | Design solutions for complex engineering problems in compliance with industry specifications, standards considering the public health and safety, and the cultural, societal, and environmental considerations. | • Object Oriented Programming<br>• Data Structures Lab<br>• Object Oriented Programming Lab<br>• Algorithms Lab<br>• Operating Systems Lab<br>• Database Systems Lab<br>• Network Programming and Simulation Lab<br>• Advanced Technology Lab<br>• Internet Tools and Technology Lab<br>• Industrial Training |
| G9: Establish meaningful relationships in working contexts,<br>G15: Work in teams collaboratively to solve given problems,<br>G28: Use organizational and managerial skills in remote and collaborative contexts,<br>G14: Communicate effectively orally and in writing | Function effectively in a team to take reasoned decisions and appreciate and respect diversity and multiculturism | • Essentials of Management<br>• Engg. Economics and Financial Management<br>• Internet Tools and Technology Lab<br>• Advanced Technology Lab<br>• Database Systems Lab<br>• Industrial Training<br>• Project Work / Practice School<br>Students participate in the majority of the team-based project.<br>Students participate in many cultural and technical events such as TechTatva, REVELS hosted by the Institution, which is solely managed by the students |

| Competencies | Description of Meta Profile | Courses |
|---|---|---|
| S12: Understanding and applying ethical, legal, economic and financial concepts in order to take decisions and manage ICT projects. | Apply ethical principles and commit to professional ethics and responsibilities so that ICT solutions follow data safety and confidentiality norms | • Essentials of Management<br>Students are encouraged to go through the ACM Code of Ethics and Profesional Conduct, available at https://www.acm.org/code-of-ethics. This exercise gives enough awareness of the code of ethics and professional conduct. |
| G6: Thinking and learning to learn for the autonomous development,<br>G21: Consider and adapt the work to emerging trends. | Be goal-oriented and recognize the need for, and have the preparation and ability to engage in life-long learning in the broadest context of technological change. | • Industrial Training<br>• Project Work / Practice School<br>Students are encouraged to participate in the following activities:<br>1. Google Summer of Codes (GSOC)<br>2. Contribution to Open Software Development<br>3. Independent research study mentored by a faculty member resulting in a research paper publication |

The additional elements related to Semester Abroad are stated in the description

With the Semester abroad program, students will get an understanding of different cultural and community perspective along with the acquisition of language where the student is perusing studies. Study abroad also makes students comfortable in foreign environments. Note that the semester abroad program is optional to the students. It is not an obligatory requirement for getting B.Tech (IT) degree.

The BTech IT programme profile matches with all the meta-profile. However, at present curriculum more emphasis on knowledge and theoretical concepts, Analysis problem solving and design. Approximate weight age given to each element of Meta Profile is as follows.

**Table 5.2**

| Meta Profile Elements | Weightage | Rationale |
|---|---|---|
| Knowledge & Theoretical Concepts | 25 | Out of 126 credits from 2nd year to 4th year, 97 credits students get from lecture hours, where the students get strong foundations on Theoretical Concepts and Knowledge on information technology. So 25% weight was given to meta profile element Knowledge & Theoretical Concepts. |
| Analysis, Problem Solving & Design | 25 | Students gain Analysis, Problem Solving & Design skills through the tutorial, quizzes and assignments. So 25% weight was given to meta profile element Analysis, Problem Solving & Design. |
| Development, Deployment & Maintenance | 15 | Students acquire software development and deployment skills through lecture and laboratory exercises. Each of the labs is associated with a semester-end capstone project which exhibits the conceptual knowledge acquired during the lab hours. |
| Interpersonal skills | 20 | Students participate in the majority of the team-based project. It gives enough opportunity to show their interpersonal skills. Also, students participate in many cultural and technical events such as TechTatva, REVELS hosted by the Institution, which is solely managed by the students and mentored by a faculty member. Students are required to undergo a compulsory one-month industrial training in a Company related to the IT sector. During the final year, they are required to undergo a minimum of four months internship in an IT industry working on a real-life project assigned by the company. In addition to the internship, students are encouraged to take up research internship either in India or abroad ( through the International Association for the Exchange of Students for Technical Experience (IAESTE) and the International Association of Students in Economic and Commercial Sciences (AIESEC). All these opportunities provide enough scope for a student to improve and enhance interpersonal skills. |
| Professional Ethics & Societal Responsibilities | 5 | At the commencement of every semester, we encourage students to go through the ACM Code of Ethics and Profesional Conduct, available at https://www.acm.org/code-of-ethics. This exercise gives enough awareness of the code of ethics and professional conduct. |
| Life long learning | 10 | To acquire life-long learning skills, students are encouraged to participate in the following activities:<br>1. Google Summer of Codes (GSOC)<br>2. Contribution to Open Software Development<br>3. Independent research study mentored by a faculty member resulting in a research paper publication |

# 6

# Structure of the programme: units/courses/modules with their learning outcomes and learning, teaching and assessment strategies

The entire programme module comprising of 8 semesters. In the first two semesters students will learn basic engineering courses like Basic Electronics, Basic Electrical Engineering and Programming Languages. In the 3rd and 4th semester students will learn core subjects like data structures, networking, database systems etc. The elective courses are offered in 4, 5, 6 and 7th semesters. The details of course structure is given below.

**Table 6.1**
Programme Structure

| Subject code | THIRD SEMESTER | | | | |
|---|---|---|---|---|---|
| | Subject Name | L | T | P | C |
| MAT 2155 | Mathematics - III | 2 | 1 | 0 | 3 |
| ICT 2151 | Data Structures | 3 | 1 | 0 | 4 |
| ICT 2152 | Digital Systems | 3 | 1 | 0 | 4 |
| ICT 2155 | Object Oriented Programming | 3 | 1 | 0 | 4 |
| ICT 2156 | Principles of Data Communication | 3 | 1 | 0 | 4 |
| ICT 2161 | Data Structures Lab | 0 | 1 | 3 | 2 |
| ICT 2162 | Digital Systems Lab | 0 | 1 | 3 | 2 |
| ICT 2163 | Object Oriented Programming Lab | 0 | 0 | 3 | 1 |
| | **TOTAL** | **14** | **7** | **9** | **24** |
| **Total Contact Hours (L + T + P)** | | **30** | | | |

| Subject code | FOURTH SEMESTER | | | | |
|---|---|---|---|---|---|
| | Subject Name | L | T | P | C |
| MAT 2256 | Mathematics - IV | 2 | 1 | 0 | 3 |
| ICT 2251 | Computer Network Protocols | 4 | 0 | 0 | 4 |
| ICT 2252 | Computer Organization and Microprocessor Systems | 3 | 0 | 0 | 3 |
| ICT 2253 | Design and Analysis of Algorithms | 3 | 1 | 0 | 4 |
| ICT 2254 | Operating Systems | 3 | 1 | 0 | 4 |
| *** **** | Open Elective - I | | | | 3 |
| ICT 2261 | Algorithms Lab | 0 | 0 | 3 | 1 |
| ICT 2262 | Microprocessor Systems Lab | 0 | 0 | 3 | 1 |
| ICT 2263 | Operating Systems Lab | 0 | 0 | 3 | 1 |
| | **TOTAL** | **15** | **3** | **9** | **24** |
| **Total Contact Hours (L + T + P) + OE** | | **27 + 3 = 30** | | | |

| Subject code | FIFTH SEMESTER | | | | |
|---|---|---|---|---|---|
| | Subject Name | L | T | P | C |
| HUM 3052 | Essentials of Management | 2 | 1 | 0 | 3 |
| ICT 3151 | Cyber Security | 3 | 0 | 0 | 3 |
| ICT 3152 | Database Systems | 3 | 0 | 0 | 3 |
| ICT 3153 | Embedded Systems | 3 | 1 | 0 | 4 |
| ICT 3154 | Software Engineering | 3 | 1 | 0 | 4 |
| *** **** | Open Elective - II | | | | 3 |
| ICT 3161 | Database Systems Lab | 0 | 1 | 3 | 2 |
| ICT 3162 | Embedded Systems Lab | 0 | 0 | 3 | 1 |
| ICT 3163 | Network Programming and Simulation Lab | 0 | 0 | 3 | 1 |
| | **TOTAL** | **14** | **4** | **9** | **24** |
| **Total Contact Hours (L + T + P) + OE** | | **27 + 3 = 30** | | | |

| Subject code | SIXTH SEMESTER | | | | |
|---|---|---|---|---|---|
| | Subject Name | L | T | P | C |
| HUM 3051 | Engg. Economics and Financial Management | 2 | 1 | 0 | 3 |
| ICT 3251 | Data Warehousing and Data Mining | 3 | 0 | 0 | 3 |
| ICT 3252 | Distributed Systems | 3 | 0 | 0 | 3 |
| ICT **** | Program Elective - I | 3 | 0 | 0 | 3 |
| ICT **** | Program Elective –II | 3 | 0 | 0 | 3 |
| *** **** | Open Elective - III | | | | 3 |
| ICT 3261 | Advanced Technology Lab | 0 | 0 | 3 | 1 |
| ICT 3262 | Data Warehousing and Data Mining Lab | 0 | 1 | 3 | 2 |
| ICT 3263 | Internet Tools and Technology Lab | 0 | 1 | 3 | 2 |
| | **TOTAL** | **14** | **3** | **9** | **23** |
| **Total Contact Hours (L + T + P) + OE** | | **26+3 = 29** | | | |

| Subject code | SEVENTH SEMESTER | | | | |
|---|---|---|---|---|---|
| | Subject Name | L | T | P | C |
| ICT **** | Program Elective - III | 3 | 0 | 0 | 3 |
| ICT **** | Program Elective - IV | 3 | 0 | 0 | 3 |
| ICT **** | Program Elective- V | 3 | 0 | 0 | 3 |
| ICT **** | Program Elective- VI | 3 | 0 | 0 | 3 |
| ICT **** | Program Elective- VII | 3 | 0 | 0 | 3 |
| *** **** | Open Elective - IV | | | | 3 |
| | **TOTAL** | **15** | **0** | **0** | **18** |
| **Total Contact Hours (L + T + P) + OE** | | **15 + 3 = 18** | | | |

| Subject code | EIGHTH SEMESTER | | | | |
|---|---|---|---|---|---|
| | Subject Name | L | T | P | C |
| ICT 4298 | Industrial Training | 0 | 0 | 0 | 1 |
| ICT 4299 | Project Work / Practice School | 0 | 0 | 0 | 12 |
| **TOTAL** | | **0** | **0** | **0** | **13** |

For each academic contact hours for theory courses a student needs to put in a minimum of three hours of effort outside the class to comprehend the content covered during the contact hours and completing the assignments or practice problems. The efforts put in by the students outside the class for each contact hours can be inferred from the grades obtained by a particular students.

| **Minor Specializations** | |
|---|---|
| **I. Computational Intelligence** | **V. Material Science** |
| CSE 4053: Artificial Intelligence | PHY ****: |
| ICT 4031: Computer Vision | PHY ****: |
| ICT 4032: Machine Learning | CHM ****: |
| CSE 4054: Soft Computing Paradigms | CHM ****: |
| **II. Computer Graphics and Visualization** | **VI. Business Management** |
| CSE 4051: Augmented and Virtual Reality | HUM 4051: Financial Management |
| ICT 4033: Computer Graphics | HUM 4052: Human Resource Management |
| ICT 4031: Computer Vision | HUM 4053: Marketing Management |
| CSE 4052: Digital Image Processing | HUM 4054: Operation Management |
| **III. Data Analytics** | |
| ICT 4034 : Big Data Analytics | **VII. Computational Mathematics** |
| ICT 4035 : Information Retrieval | MAT 4051: Applied Statistics and Time Series Analysis |
| ICT 4032 : Machine Learning | MAT 4052: Computational Linear Algebra |
| ICT 4036 : Semantic Web | MAT 4053: Computational Probability and Design of Experiments |
| **IV. Software System Design** | MAT 4054: Graphs and Matrices |
| ICT 4037 : Advanced Software Engineering | |
| ICT 4038 : Software Architecture | |
| ICT 4039: Software Project and Quality Management | |
| ICT 4040 : Software Construction | |

| **Other Program Electives** |
| --- |
| ICT 4045: Cloud Computing |
| ICT 4046: Deep Learning |
| ICT 4047: Game Theory with Computer Applications |
| ICT 4048: High Performance Computing |
| ICT 4049: Human Computer Interaction |
| ICT 4050: Internet of Things |
| ICT 4051: Natural Computing |
| ICT 4052: Neural Networks and Fuzzy Logic |
| ICT 4053: Pattern Recognition |
| ICT 4054: Social Network Analysis |
| ICT 4055: Software Reliability |
| |
| **Open Electives** |
| ICT 4301: Computer Graphics and Animation |
| ICT 4302: Design and Development of Web Applications |
| ICT 4303: Fundamentals of Data Structures and Algorithms |
| ICT 4304: Machine Learning Tools and Technologies |
| ICT 4305: Networking with TCP/IP |

Different assessment tools are used to assess the Course Outcome. These are:

- Four surprise quizzes (5 marks each)
- Two sessional tests (15 marks each)
- End semester examination (50 marks)

Below is the sample template for the same.

**Table 6.2**

| Components | Quizzes | Sessional Tests | End Semester /Make-up Examination |
|---|---|---|---|
| Duration | 20 to 30 minutes | 60 minutes | 180 minutes |
| Weightage | 20% (4 * 5 Marks) | 30% (2 * 15 Marks) | 50% (1 * 50 Marks) |
| Typology of Questions | Understanding/Comprehension; Application; Analysis; Synthesis; Evaluation | Knowledge/Recall; Understanding/ Comprehension; Application | Understanding/Comprehension; Application; Analysis; Synthesis; Evaluation |
| Pattern | Answer one randomly selected question from the problem sheet. (Students can refer their class notes ) | MCQ: 10 Questions (0.5 marks)<br>Short Answers: 5 questions (2 marks) | Answer all 5 full questions of 10 marks each. Each question may have 2 to 3 parts of 3/4/5/6/7 marks. |
| Schedule | 4, 7, 10, and 13th week of academic calendar. | Calendared activity | Calendared activity |
| Topics Covered | Assignment/Quiz 1 (L1-7 & T) (CO1,2)<br>Assignment/Quiz 2 (L8-15 & T) (CO1,2) | Test 1 2 (L1-15 & T) (CO1,2) | Comprehensive examination covering full syllabus. Students are expected to answer all the questions. |
| | Assignment/Quiz 3 (L16-24 & T) (CO1,2,3)<br>Assignment/Quiz 4 (L25-34 & T) (CO1,2,4) | Test 2 (L16-27 & T) (CO1,2,3, 4) | |

The Information Technology courses are delivered through the class room lectures and tutorials. The program adheres to the academic calendar provided for each academic year by the institute. The theoretical courses are very well supported by laboratory courses. Industrial training is a mandatory course wherein the students undergo real-time experience with complex engineering activities. Apart from all the said course delivery methods, the program also includes courses namely Project Work/Practice School, wherein the students' knowledge, skill and attitude are polished.

We have defined Course Performance Rubric using which success is monitored.

| Course Performance Rubric | | | | |
|---|---|---|---|---|
| particulars | Excellent | Very Good | Satisfactory | Needs improvements |
| Average Pass Grade | (7 t0 7.5) | (>=6.5 to < 7 OR >7.5 to <= 8 | (>=6 and <6.5 or >8 to <=8.5 | (<6 OR >8.5) |

The theory-based courses are assessed generally through in semester tests, assignments and end semester examinations. Experience of solving open-ended problems are provided through the projects taken up by students in a few courses. The laboratory courses follow a continuous evaluation process. The students are evaluated based on the experiments conducted and the submitted report. The students are expected to demonstrate their experimentation skills, self-learning and achieve familiarity with appropriate tools in the laboratory courses

Courses are designed with the help of experts (industry and academia) and care is taken to see that there is no overlapping of topics in more than one course.

**Table 6.6.1**

| Course (name and code) | Competance | Course/paper learning outcomes | Learning and teaching activities related to each course/paper learning outcome | Assessment activities (formative and summative) related to each course/ paper learning outcome |
|---|---|---|---|---|
| Mathematics - III (MAT 2155) | S1 | CO1: Learn algebraic structures and their importance | Chalk and board teaching augmented by power point presentation<br>Frequent tutorials conducted to acquire better comprehension and problem solving skills | Quiz/assignments, Sessional,<br>End semester examination |
| | S1 | CO2: Understand the combinatorial theory | | |
| | S1 | CO3: Know the basic concept in graph theoryvertices in a network. | | |
| | S1 | CO4: Understand how to construct valid mathematical statements and arguments. | | |
| Data Structures (ICT 2151) | G26 | CO1: Relate the concepts of arrays, dynamic memory management, class, searching, sorting | Chalk and board teaching augmented by power point presentation<br>Frequent tutorials conducted to acquire better comprehension and problem solving skills | Quiz/assignments, Sessional,<br>End semester examination |
| | G4 | CO2: Illustrate the working of linear and non-linear data structure. | | |
| | S5 | CO3: Apply the appropriate data structure to solve real world problems. | | |
| Digital Systems (ICT 2152) | G4 | CO1: Identify the applications of various elements of digital system abstractions | Chalk and board teaching augmented by power point presentation<br>Frequent tutorials conducted to acquire better comprehension and problem solving skills | Quiz/assignments, Sessional,<br>End semester examination |
| | S1 | CO2: Transform complex Boolean expressions using Boolean theorems, K-Map, tabulation methods. | | |
| | S5 | CO3: Design combinational and sequential logic circuits. | | |
| | G4 | CO4: Classify different memory devices of a computer | | |

| Course (name and code) | Competance | Course/paper learning outcomes | Learning and teaching activities related to each course/paper learning outcome | Assessment activities (formative and summative) related to each course/ paper learning outcome |
|---|---|---|---|---|
| Object Oriented Programming (ICT 2155) | S5 | CO1: Develop simple applications using Java primitives | Chalk and board teaching augmented by power point presentation<br>Frequent tutorials conducted to acquire better comprehension and problem solving skills | Quiz/assignments, Sessional,<br>End semester examination |
| | S5 | CO2: Implement OOP Concepts using JAVA | | |
| | G4 | CO3: Use inbuilt library packages of JAVA | | |
| | S6 | CO4: Develop Java application using object oriented concepts | | |
| | S5 | CO5: Write simple concurrent programs using | | |
| Principles of Data Communication (ICT 2156) | S1 | CO1: Outline the basics of data communication | Chalk and board teaching augmented by power point presentation<br>Frequent tutorials conducted to acquire better comprehension and problem solving skills | Quiz/assignments, Sessional,<br>End semester examination |
| | S5 | CO2: Compute frame check sequence and error correction | | |
| | S1 | CO3: Explain data link layer protocol | | |
| | s1 | CO4: Compute the performance of media access | | |
| Data Structures Lab ( ICT 2161) | S8 | CO1: Identify suitable data structures for the given problem | To augment and enhance the comprehension of the concepts taught during the theory courses, students are given real-life programming problems involving those concepts. | Viva, execution check, recording experimental results,<br>End semester examination |
| | S8 | CO2: Associate suitable searching and sorting techniques for the given data structure | | |
| | S8 | CO3: Demonstrate the working of linear and non-linear data structure | | |
| Digital Systems Lab (ICT 2162) | S5 | CO1: Interpret the working of a digital circuit | To augment and enhance the comprehension of the concepts taught during the theory courses, students are given real-life programming problems involving those concepts. | Viva, execution check, recording experimental results,<br>End semester examination |
| | S5 | CO2: Design a digital logic circuit for a given problem by applying the principles of digital design | | |
| Object Oriented Programming Lab (ICT 2163) | S8 | CO1: Implement Object Oriented Programming Concepts | To augment and enhance the comprehension of the concepts taught during the theory courses, students are given real-life programming problems involving those concepts. | Viva, execution check, recording experimental results,<br>End semester examination |
| | S8 | CO2: Use and create packages and interfaces, collections, implement exception handling | | |
| | S8 | CO3: Implement string programs, use input/output streams, create | | |

| Course (name and code) | Competance | Course/paper learning outcomes | Learning and teaching activities related to each course/paper learning outcome | Assessment activities (formative and summative) related to each course/ paper learning outcome |
|---|---|---|---|---|
| Mathematics - IV (MAT 2256) | S1 | CO1: Discuss the relevance of probability in engineering problems. | Chalk and board teaching augmented by power point presentation<br>Frequent tutorials conducted to acquire better comprehension and problem solving skills | Quiz/assignments, Sessional,<br>End semester examination |
| | S1 | CO2: Explain the concepts of random variable and probability distribution | | |
| | S1 | CO3: Identify situation where different discrete probability distribution can be applied. | | |
| | S1 | CO4: Use suitable continuous distributions to various situations. | | |
| | S1 | CO5: Understand the measures of probability distributions, point estimations and interval estimations. | | |
| Computer Network Protocols (ICT 2251) | S1 | CO1: Illustrate the proper usage of various protocols that has been used in the different layers of TCP/IP protocol suite | Chalk and board teaching augmented by power point presentation<br>Frequent tutorials conducted to acquire better comprehension and problem solving skills | Quiz/assignments, Sessional,<br>End semester examination |
| | S1 | CO2: Interpolate the basic protocols of computer networks in network design and implementation | | |
| | S5 | CO3: Apply various protocols to solve challenges in a given scenario | | |
| Computer Organization and Microprocessor Systems (ICT 2252) | S1 | CO1: Recall 8086 architecture | Chalk and board teaching augmented by power point presentation<br>Frequent tutorials conducted to acquire better comprehension and problem solving skills | Quiz/assignments, Sessional,<br>End semester examination |
| | S5 | CO2: Write assembly language programs using development tools | | |
| | S1 | CO3: Understand the interfacing of programmable devices to 8086 microprocessor | | |
| | S1 | CO4: Understand the organization of various parts in computer system | | |
| | S1 | CO5: Design building blocks of computer system | | |

| Course (name and code) | Competance | Course/paper learning outcomes | Learning and teaching activities related to each course/paper learning outcome | Assessment activities (formative and summative) related to each course/ paper learning outcome |
|---|---|---|---|---|
| Design and Analysis of Algorithms (ICT 2253) | S1 | CO1: Understand asymptotic notations to represent the complexities of algorithms | Chalk and board teaching augmented by power point presentation<br>Frequent tutorials conducted to acquire better comprehension and problem solving skills | Quiz/assignments, Sessional,<br>End semester examination |
| | S1 | CO2: Understand the basic concepts of graph traversal methods | | |
| | G4 | CO3: Apply various algorithm designing techniques for a given problem | | |
| | S5 | CO4: Comprehend the basic concepts of trees and hashing techniques | | |
| | S1 | CO5: Understand NP complete and NP hard problems | | |
| Operating Systems (ICT 2254) | S1 | CO1: Acquire detailed understanding of operating system functionalities | Chalk and board teaching augmented by power point presentation<br>Frequent tutorials conducted to acquire better comprehension and problem solving skills | Quiz/assignments, Sessional,<br>End semester examination |
| | G26 | CO2: Apply the knowledge to solve issues in process as well as memory management | | |
| | S1 | CO3: Able to understand the fundamental concepts of real time operating | | |
| | S1 | CO4: Apply the knowledge to understand modern operating systems concepts | | |
| Algorithms Lab (ICT 2261) | S8 | CO1: Implement an algorithm to find path between any two vertices in the given graph | To augment and enhance the comprehension of the concepts taught during the theory courses, students are given real-life programming problems involving those concepts. | Viva, execution check, recording experimental results,<br>End semester examination |
| | S8 | CO2: Apply the knowledge of shortest path algorithms for real world problems. | | |
| | S8 | CO3: Implement Greedy, Divide and Conquer, Dynamic Programming, Back tracking and Branch and Bound techniques to solve different problems. | | |
| | S8 | CO4: Implement approximation algorithm for travelling sales person and vertex cover problem. | | |

| Course (name and code) | Competance | Course/paper learning outcomes | Learning and teaching activities related to each course/paper learning outcome | Assessment activities (formative and summative) related to each course/ paper learning outcome |
|---|---|---|---|---|
| Microprocessor Systems Lab (ICT 2262) | S1 | CO1: Use assembly language development tool | To augment and enhance the comprehension of the concepts taught during the theory courses, students are given real-life programming problems involving those concepts. | Viva, execution check, recording experimental results,<br>End semester examination |
| | S1 | CO2: Extend the knowledge of instruction set for writing efficient programs | | |
| | S5 | CO3: Use subroutine concepts in programming | | |
| | S5 | CO4: Write the programs using DOS interrupts | | |
| | S5 | CO5: Apply the knowledge of advanced screen processing concepts | | |
| Operating Systems Lab (ICT 2263) | S1 | CO1: Understand the working of UNIX based operating system | To augment and enhance the comprehension of the concepts taught during the theory courses, students are given real-life programming problems involving those concepts. | Viva, execution check, recording experimental results,<br>End semester examination |
| | S1 | CO2: Illustrate the process management in operating systems. | | |
| | S8 | CO3: Implement CPU scheduling as well as synchronization algorithms. | | |
| | S8 | CO4: Implement algorithms used to understand the functionality of modern operating systems. | | |
| Essentials of Management (HUM 3052) | G28 | CO1: Make comparisons of project alternatives during the planning and implementation phases | Chalk and board teaching augmented by power point presentation<br>Frequent tutorials conducted to acquire better comprehension and problem solving skills.<br>Group disscussion | Quiz/assignments, Sessional,<br>End semester examination |
| | S12 | CO2: Determine the future value of a payment made in the present | | |
| | S12 | CO3: Distinguish the present value of a payment to be made in the future | | |
| | S12 | CO4: Estimate the future value of periodic payments | | |
| | S12 | CO5: Compare and contrast the interest rate required on an investment to achieve a future sum | | |
| | G28 | CO6 : Compute the annual worth of proposed alternatives | | |
| | G28 | CO7 : Describe the best time to replace an aging asset | | |
| | G28 | CO8: Explain the best method of depreciation to minimize tax liability | | |

| Course (name and code) | Competance | Course/paper learning outcomes | Learning and teaching activities related to each course/paper learning outcome | Assessment activities (formative and summative) related to each course/ paper learning outcome |
|---|---|---|---|---|
| Cyber Security (ICT 3151) | S11 | CO1: Understand the basics of cyber security. | Chalk and board teaching augmented by power point presentation<br>Frequent tutorials conducted to acquire better comprehension and problem solving skills | Quiz/assignments, Sessional,<br>End semester examination |
| | S11 | CO2: Evaluate attacks on operating system, network and web. | | |
| | S11 | CO3:Analyze the existing vulnerabilities and propose solutions. | | |
| | G1 | CO4: Examine real case studies of cyber security incidents and their mitigation. | | |
| Database Systems (ICT 3152) | S1 | CO1: Understand the database concepts. | Chalk and board teaching augmented by power point presentation<br>Frequent tutorials conducted to acquire better comprehension and problem solving skills | Quiz/assignments, Sessional,<br>End semester examination |
| | S5 | CO2: Apply procedural and non-procedural language constructs to manage database system | | |
| | S5 | CO3: Design database using data modelling tool and normalization concepts | | |
| | S1 | CO4: Describe transaction management and concurrency control concepts | | |
| | S1 | CO5: Interpret the unstructured databases | | |
| Embedded Systems (ICT 3153) | S1 | CO1: Familiarise with the salient features of embedded systems | Chalk and board teaching augmented by power point presentation<br>Frequent tutorials conducted to acquire better comprehension and problem solving skills | Quiz/assignments, Sessional,<br>End semester examination |
| | S1 | CO2: Illustrate the architecture of ARM Cortex- M microcontroller | | |
| | S5 | CO3: Familiarise with the efficient software design for embedded systems | | |
| | S1 | CO4: Outline software development for ARM Cortex-M microcontroller | | |
| | S5 | CO5: Design real world systems using ARM Cortex-M microcontroller | | |

| Course (name and code) | Competance | Course/paper learning outcomes | Learning and teaching activities related to each course/paper learning outcome | Assessment activities (formative and summative) related to each course/ paper learning outcome |
|---|---|---|---|---|
| Software Engineering (ICT 3154) | S1 | CO1: Understand the basics of software development life cycle. | Chalk and board teaching augmented by power point presentation<br>Frequent tutorials conducted to acquire better comprehension and problem solving skills | Quiz/assignments, Sessional,<br>End semester examination |
| | S1 | CO2: Understand the basic principles behind software configuration and risk management | | |
| | S1 | CO3: Explore the importance of requirement analysis through scenario based exercise | | |
| | S1 | CO4: Adapt software design strategies using object oriented concepts | | |
| | G4 | CO5: Identify a suitable testing strategy to validate a given software application | | |
| Database Systems Lab (ICT 3161) | S8 | CO1: Implement a graphical user interface (GUI) and access database through GUI using an integrated development environment.: | To augment and enhance the comprehension of the concepts taught during the theory courses, students are given real-life programming problems involving those concepts. | Viva, execution check, recording experimental results,<br>End semester examination |
| | S8 | CO2: Design, create and query the relational database using structured query language. | | |
| | S8 | CO3: Demonstrate the working of procedural and non-procedural language. | | |
| | S8 | CO4: Perform create, read, update and delete operations on MongoDB | | |
| | S8 | CO5: Implement a mini project that provides solution to a real world problem. | | |
| Embedded Systems Lab (ICT 3162) | S5 | CO1: Recall the basics of an embedded system | To augment and enhance the comprehension of the concepts taught during the theory courses, students are given real-life programming problems involving those concepts. | Viva, execution check, recording experimental results,<br>End semester examination |
| | S5 | CO2: Program an embedded system using ARM controller | | |
| | S5 | CO3: Design, implement and test an embedded system. | | |
| Network Programming and Simulation Lab (ICT 3163) | S6 | CO1: Implement client server socket programming | To augment and enhance the comprehension of the concepts taught during the theory courses, students are given real-life programming problems involving those concepts. | Viva, execution check, recording experimental results,<br>End semester examination |
| | S5 | CO2: Simulate the network concepts using packet tracer. | | |

| Course (name and code) | Competance | Course/paper learning outcomes | Learning and teaching activities related to each course/paper learning outcome | Assessment activities (formative and summative) related to each course/ paper learning outcome |
|---|---|---|---|---|
| Engg. Economics and Financial Management (HUM 3051) | G28 | CO1: Understand the roles of mangers, principles of management, and managerial skills | Chalk and board teaching augmented by power point presentation<br>Frequent tutorials conducted to acquire better comprehension and problem solving skills | Quiz/assignments, Sessional,<br>End semester examination |
| | G28 | CO2: Develop an organization structure and plan for manpower in a given business organization | | |
| | G28 | CO3: Set objectives and propose strategies to accomplish them in a business | | |
| | G9 | CO4: Apply leadership and motivational theories in the organizational context | | |
| | G26 | CO5: Acquire budgetary skills | | |
| | G28 | CO6: Understand the salient international business theories and practices | | |
| | G28 | CO7: Prepare a business plan | | |
| Data Warehousing and Data Mining (ICT 3251) | S5 | CO1: Apply pre-processing techniques on datasets | Chalk and board teaching augmented by power point presentation<br>Frequent tutorials conducted to acquire better comprehension and problem solving skills | Quiz/assignments, Sessional,<br>End semester examination |
| | S5 | CO2: Describe the data warehouse architecture for facilitating querying | | |
| | S5 | CO3: Identify data mining techniques and apply on datasets | | |
| | S5 | CO4: Identify web mining techniques | | |
| Distributed Systems (ICT 3252) | S1 | CO1: Understand basic concepts of distributed systems | Chalk and board teaching augmented by power point presentation<br>Frequent tutorials conducted to acquire better comprehension and problem solving skills | Quiz/assignments, Sessional,<br>End semester examination |
| | S1 | CO2: Understand various techniques used for communication between distributed systems | | |
| | S1 | CO3: Analyze the requirements for designing distributed file system and shared memory | | |
| | S1 | CO4: Understand the issues pertaining to coordination, consistency, fault tolerance for a distributed system | | |
| | S1 | CO5: Identify the concepts of distributed system to design any distributed application | | |

| Course (name and code) | Competance | Course/paper learning outcomes | Learning and teaching activities related to each course/paper learning outcome | Assessment activities (formative and summative) related to each course/ paper learning outcome |
|---|---|---|---|---|
| Advanced Technology Lab (ICT 3261) | S6 | CO1: Recognize the emerging technology used in the software industry | To augment and enhance the comprehension of the concepts taught during the theory courses, students are given real-life programming problems involving those concepts. | Viva, execution check, recording experimental results,<br>End semester examination |
| | S6 | CO2: Construct the database that interacts with the application | | |
| | S6 | CO3: Develop the GUI for the application | | |
| | S6 | CO4: Select the appropriate tools and techniques to implement application | | |
| Data Warehousing and Data Mining Lab (ICT 3262) | S5 | CO1: Identify suitable preprocessing techniques for various dataset | To augment and enhance the comprehension of the concepts taught during the theory courses, students are given real-life programming problems involving those concepts. | Viva, execution check, recording experimental results,<br>End semester examination |
| | S5 | CO2: Develop data warehouse | | |
| | S5 | CO3: Apply suitable data mining technique on preprocessed data | | |
| Internet Tools and Technology Lab (ICT 3263) | S8 | CO1: Design and develop dynamic web pages with good aesthetic sense of designing and latest technical know-how's | To augment and enhance the comprehension of the concepts taught during the theory courses, students are given real-life programming problems involving those concepts. | Viva, execution check, recording experimental results,<br>End semester examination |
| | S8 | CO2: Have a good understanding of Web Application Terminologies, Internet Tools other web services | | |
| | S8 | CO3: Understand and implement the client and server side programming for a Web application using latest tools | | |
| Industrial Training (ICT 4298) | G15 | CO1: Be acquainted with working environment at the Software Industries. | Students are required to undergo a compulsory 4 week industrial training anytime after the fourth semester in an industry. | Students are required to appear for the viva-voce based on the work done during the internship. |
| | S6 | CO2:Be acquainted with processes that are in place at the Software Industries. | | |
| | G21 | CO3:Familiarize the challenges as Software professionals. | | |
| | G14 | CO4:Effectively write a technical report. | | |

| Course (name and code) | Competance | Course/paper learning outcomes | Learning and teaching activities related to each course/paper learning outcome | Assessment activities (formative and summative) related to each course/ paper learning outcome |
|---|---|---|---|---|
| Project Work / Practice School (ICT 4299) | G6 | CO1: Identify real world problems in the field of information and communication technology. | Final semester project has to be undertaken in an IT industry working on the industrial problems defined by the concerned company. | Students are required to update their respective internal guide (faculty member assigned from the department) on weekly basis about the work done. Also they are required to appear for in person presentation cum demo followed by viva-voce on two occasions: midterm and end sem. |
| | S5 | CO2: Design methodologies with implementation. | | |
| | G14 | CO3: Write technical report | | |
| | G14 | CO4: Communicate effectively. | | |

## Table 6.6.2

| | | cluster 1 | | cluster 2 | | | | cluster 3 | | Cluster 4 | | | | Cluster 5 | Cluster 6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | G1 | S1 | G4 | G26 | S5 | S11 | S6 | S8 | G9 | G15 | G28 | G14 | S12 | G6 | G21 |
| MAT 2155 | Mathematics - III | | X | | | | | | | | | | | | | |
| ICT 2151 | Data Structures | | | X | X | X | | | | | | | | | | |
| ICT 2152 | Digital Systems | | X | X | | X | | | | | | | | | | |
| ICT 2155 | Object Oriented Programming | | | X | | X | | X | | | | | | | | |
| ICT 2156 | Principles of Data Communication | | X | | | X | | | | | | | | | | |
| ICT 2161 | Data Structures Lab | | | | | | | | X | | | | | | | |
| ICT 2162 | Digital Systems Lab | | | | | X | | | | | | | | | | |
| ICT 2163 | Object Oriented Programming Lab | | | | | | | | X | | | | | | | |
| MAT 2256 | Mathematics - IV | | X | | | | | | | | | | | | | |
| ICT 2251 | Computer Network Protocols | | X | | | X | | | | | | | | | | |
| ICT 2252 | Computer Organization and Micro-processor Systems | | X | | | X | | | | | | | | | | |
| ICT 2253 | Design and Analysis of Algorithms | | X | X | | X | | | | | | | | | | |
| ICT 2254 | Operating Systems | | X | | X | | | | | | | | | | | |
| ICT 2261 | Algorithms Lab | | | | | | | | X | | | | | | | |
| ICT 2262 | Microprocessor Systems Lab | | X | | | X | | | | | | | | | | |
| ICT 2263 | Operating Systems Lab | | X | | | | | | X | | | | | X | | |
| HUM 3052 | Essentials of Management | | | | | | | | | | | X | | X | | |
| ICT 3151 | Cyber Security | X | | | | | X | | | | | | | | | |
| ICT 3152 | Database Systems | | X | | | X | | | | | | | | | | |
| ICT 3153 | Embedded Systems | | X | | | X | | | | | | | | | | |
| ICT 3154 | Software Engineering | | X | X | | | | | | | | | | | | |
| ICT 3161 | Database Systems Lab | | | | | | | | X | | X | | | | | |
| ICT 3162 | Embedded Systems Lab | | X | | | X | | | | | | | | | | |
| ICT 3163 | Network Programming and Simulation Lab | | | | | X | | X | | | | | | | | |
| HUM 3051 | Engg. Economics and Financial Manage-ment | | | | X | | | | | X | | X | | | | |
| ICT 3251 | Data Warehousing and Data Mining | | | | | X | | | | | | | | | | |
| ICT 3252 | Distributed Systems | | X | | | | | | | | | | | | | |
| ICT 3261 | Advanced Technology Lab | | | | | | | X | | | X | | | | | |
| ICT 3262 | Data Warehousing and Data Mining Lab | | | | | X | | | | | | | | | | |
| ICT 3263 | Internet Tools and Technology Lab | | | | | | | X | | | X | | | | | |
| ICT 4298 | Industrial Training | | | | | | X | | | X | | X | | | X | |
| ICT 4299 | Project work/Practice school | | | | X | | | | | X | | X | | X | | |

# 7

# Length of the programme and student workload

Table 7.2

| Course/paper | Number of contact hours | Number of hours students need to work on this course/paper outside the classroom in order to successfully meet the course/paper requirements (revision of notes, completion of assignments, preparation of presentations, work in the library, preparation for intermediate and final assessments, etc.) |
|---|---|---|
| 4 credit course such as ICT 2151, 2152, ICT2153 etc | 4 | Each 4 credit involves 4 hours of in-class contact followed by 12 hourse of out of class work on revision of notes, completion of assignments, and work in the library per week. |
| 3 credit course ICT 3151, 3152, ICT3153 etc | 3 | Each 3 credit involves 3 hours of in-class contact followed by 9 hourse of out of class work on revision of notes, completion of assignments, and work in the library per week. |
| 2 credit lab such as ICT2161, ICT 2162 | 4 | Each 2 credit lab involves 1 hour of tutorial and 3 hours of Conducting lab experiments followed by 6 hourse of out of class work on writing the records, completion of pending experiments. |
| 1 credit lab such as ICT 4298 etc | 3 | Each 1 credit lab involves 3 hours of conducting lab experiments followed by 3 hourse of out of class work on writing the records, completion of pending experiments. |
| 1 credit industrial training | — | Students spend approximately 48 hours per week (8* 6) for a period of 4 week in the industry. |
| 12 credit project wordk | — | Students spend approximately 48 hours per week (8* 6) for a period of 4 Month in the industry/academia |

For each academic contact hours for theory courses a student needs to put in a minimum of three hours of effort outside the class to comprehend the content covered during the contact hours and completing the assignments or practice problems. The efforts put in by the students outside the class for each contact hours can be inferred from the grades obtained by a particular students.

| Semester | Course Code | Course | Students workload, hours | | | Total Students' Workload (F+G+H), hours | ECTS Credits (I / 30) |
|---|---|---|---|---|---|---|---|
| | | | Contact hours (Guided Learning, face to face activities, lectures, labs, tutorials, etc | Independent work (self-learning, non face-to-face activities, revision, homework, etc) | Others: Continuous Assessment (Test, Quiz, Final Exam) | | |
| 3 | MAT 2155 | Mathematics - III | 36 | 54 | 6,2 | 96,2 | 3,20 |
| | ICT 2153 | Data Structures | 48 | 72 | 6,2 | 126,2 | 4,20 |
| | ICT 2154 | Digital Systems | 48 | 72 | 6,2 | 126,2 | 4,20 |
| | ICT 2155 | Object Oriented Programming | 48 | 72 | 6,2 | 126,2 | 4,20 |
| | ICT 2156 | Principles of Data Communication | 48 | 72 | 6,2 | 126,2 | 4,20 |
| | ICT 2162 | Data Structures Lab | 36 | 18 | 2,0 | 56,0 | 1,86 |
| | ICT 2163 | Digital Systems Lab | 36 | 18 | 2,0 | 56,0 | 1,86 |
| | ICT 2164 | Object Oriented Programming Lab | 36 | 18 | 2,0 | 56,0 | 1,86 |
| 4 | MAT 2256 | Mathematics - IV | 36 | 54 | 6,2 | 96,2 | 3,20 |
| | ICT 2255 | Computer Network Protocols | 48 | 72 | 6,2 | 126,2 | 4,20 |
| | ICT 2256 | Computer Organization and Microprocessor Systems | 36 | 54 | 6,2 | 96,2 | 3,20 |
| | ICT 2257 | Design and Analysis of Algorithms | 48 | 72 | 6,2 | 126,2 | 4,20 |
| | ICT 2258 | Operating Systems | 48 | 72 | 6,2 | 126,2 | 4,20 |
| | *** **** | Open Elective - I | 36 | 54 | 6,2 | 96,2 | 3,20 |
| | ICT 2263 | Algorithms Lab | 36 | 18 | 2,0 | 56,0 | 1,86 |
| | ICT 2264 | Microprocessor Systems Lab | 36 | 18 | 2,0 | 56,0 | 1,86 |
| | ICT 2265 | Operating Systems Lab | 36 | 18 | 2,0 | 56,0 | 1,86 |
| 5 | HUM 3152 | Essentials of Management | 36 | 54 | 6,2 | 96,2 | 3,20 |
| | ICT 3156 | Cyber Security | 36 | 54 | 6,2 | 96,2 | 3,20 |
| | ICT 3157 | Database Systems | 36 | 54 | 6,2 | 96,2 | 3,20 |
| | ICT 3158 | Embedded Systems | 48 | 72 | 6,2 | 126,2 | 4,20 |
| | ICT 3159 | Software Engineering | 48 | 72 | 6,2 | 126,2 | 4,20 |
| | *** **** | Open Elective - II | 36 | 54 | 6,2 | 96,2 | 3,20 |
| | ICT 3163 | Database Systems Lab | 36 | 18 | 2,0 | 56,0 | 1,86 |
| | ICT 3164 | Embedded Systems Lab | 36 | 18 | 2,0 | 56,0 | 1,86 |
| | ICT 3165 | Network Programming and Simulation Lab | 36 | 18 | 2,0 | 56,0 | 1,86 |

| Semester | Course Code | Course | Students workload, hours | | | Total Students' Workload (F+G+H), hours | ECTS Credits (I / 30) |
|---|---|---|---|---|---|---|---|
| | | | Contact hours (Guided Learning, face to face activities, lectures, labs, tutorials, etc | Independent work (self-learning, non face-to-face activities, revision, homework, etc) | Others: Continuous Assessment (Test, Quiz, Final Exam) | | |
| 6 | HUM 3151 | Engg. Economics and Financial Management | 36 | 54 | 6,2 | 96,2 | 3,20 |
| | ICT 3253 | Data Warehousing and Data Mining | 36 | 54 | 6,2 | 96,2 | 3,20 |
| | ICT 3254 | Distributed Systems | 36 | 54 | 6,2 | 96,2 | 3,20 |
| | ICT **** | Program Elective - I | 36 | 54 | 6,2 | 96,2 | 3,20 |
| | ICT **** | Program Elective –II | 36 | 54 | 6,2 | 96,2 | 3,20 |
| | *** **** | Open Elective - III | 36 | 54 | 6,2 | 96,2 | 3,20 |
| | ICT 3264 | Advanced Technology Lab | 36 | 18 | 2,0 | 56,0 | 1,86 |
| | ICT 3265 | Data Warehousing and Data Mining Lab | 36 | 18 | 2,0 | 56,0 | 1,86 |
| | ICT 3266 | Internet Tools and Technology Lab | 36 | 18 | 2,0 | 56,0 | 1,86 |
| 7 | ICT **** | Program Elective - III | 36 | 54 | 6,2 | 96,2 | 3,20 |
| | ICT **** | Program Elective - IV | 36 | 54 | 6,2 | 96,2 | 3,20 |
| | ICT **** | Program Elective- V | 36 | 54 | 6,2 | 96,2 | 3,20 |
| | ICT **** | Program Elective- VI | 36 | 54 | 6,2 | 96,2 | 3,20 |
| | ICT **** | Program Elective- VII | 36 | 54 | 6,2 | 96,2 | 3,20 |
| | *** **** | Open Elective - IV | 36 | 54 | 6,2 | 96,2 | 3,20 |
| 8 | ICT 4298 | Industrial Training | 0 | 96 | 0,0 | 96,0 | 3,20 |
| | ICT 4299 | Project work/Pracitice school | 0 | 384 | 1,5 | 385,5 | 12,85 |

# 8

# Overall consistency of the programme

All Core Courses contribute to the achievement of one programme-level learning outcome.

Each course is associated with 3 to 5 course outcomes (COs) . Quizzes, sessional tests and end semester examination are used to assess course outcomes. These CO assessments are mapped to one or more program outcome.

**Table 8.4.1**

| Course (name and code) | Course/paper learning outcomes | Metaprofile Custer | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| Mathematics – III (MAT 2155) | CO1: Learn algebraic structures and their importance | X | | | | | |
| | CO2: Understand the combinatorial theory | X | | | | | |
| | CO3: Know the basic concept in graph theoryvertices in a network. | X | | | | | |
| | CO4: Understand how to construct valid mathematical statements and arguments. | X | | | | | |
| Data Structures (ICT 2151) | CO1: Relate the concepts of arrays, dynamic memory management, class, searching, sorting | | X | | | | |
| | CO2: Illustrate the working of linear and non-linear data structure. | | X | | | | |
| | CO3: Apply the appropriate data structure to solve real world problems. | | X | | | | |
| Digital Systems (ICT 2152) | CO1: Identify the applications of various elements of digital system abstractions | | X | | | | |
| | CO2: Transform complex Boolean expressions using Boolean theorems, K-Map, tabulation methods. | X | | | | | |
| | CO3: Design combinational and sequential logic circuits. | | X | | | | |
| | CO4: Classify different memory devices of a computer | | X | | | | |
| Object Oriented Programming (ICT 2153) | CO1: Develop simple applications using Java primitives | | X | | | | |
| | CO2: Implement OOP Concepts using JAVA | | X | | | | |
| | CO3: Use inbuilt library packages of JAVA | | X | | | | |
| | CO4: Develop Java application using object oriented concepts | | | X | | | |
| | CO5: Write simple concurrent programs using | | X | | | | |

| Course (name and code) | Course/paper learning outcomes | Metaprofile Custer | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| Principles of Data Communication (ICT 2154) | CO1: Outline the basics of data communication | X | | | | | |
| | CO2: Compute frame check sequence and error correction | | X | | | | |
| | CO3: Explain data link layer protocol | X | | | | | |
| | CO4: Compute the performance of media access | X | | | | | |
| Data Structures Lab (ICT 2161) | CO1: Identify suitable data structures for the given problem | | | X | | | |
| | CO2: Associate suitable searching and sorting techniques for the given data structure | | | X | | | |
| | CO3: Demonstrate the working of linear and non-linear data structure | | | X | | | |
| Digital Systems Lab (ICT 2162) | CO1: Interpret the working of a digital circuit | | X | | | | |
| | CO2: Design a digital logic circuit for a given problem by applying the principles of digital design | | X | | | | |
| Object Oriented Programming Lab (ICT 2163) | CO1: Implement Object Oriented Programming Concepts | | | X | | | |
| | CO2: Use and create packages and interfaces, collections, implement exception handling | | | X | | | |
| | CO3: Implement string programs, use input/output streams, create | | | X | | | |
| Mathematics - IV (MAT 2256) | CO1: Discuss the relevance of probability in engineering problems. | X | | | | | |
| | CO2: Explain the concepts of random variable and probability distribution | X | | | | | |
| | CO3: Identify situation where different discrete probability distribution can be applied. | X | | | | | |
| | CO4: Use suitable continuous distributions to various situations. | X | | | | | |
| | CO5: Understand the measures of probability distributions, point estimations and interval estimations. | X | | | | | |
| Computer Network Protocols (ICT 2251) | CO1: Illustrate the proper usage of various protocols that has been used in the different layers of TCP/IP protocol suite | X | | | | | |
| | CO2: Interpolate the basic protocols of computer networks in network design and implementation | X | | | | | |
| | CO3: Apply various protocols to solve challenges in a given scenario | | X | | | | |
| Computer Organization and Microprocessor Systems (ICT 2252) | CO1: Recall 8086 architecture | X | | | | | |
| | CO2: Write assembly language programs using development tools | | X | | | | |
| | CO3: Understand the interfacing of programmable devices to 8086 microprocessor | X | | | | | |
| | CO4: Understand the organization of various parts in computer system | X | | | | | |
| | CO5: Design building blocks of computer system | X | | | | | |

| Course (name and code) | Course/paper learning outcomes | Metaprofile Custer | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| Design and Analysis of Algorithms (ICT 2253) | CO1: Understand asymptotic notations to represent the complexities of algorithms | X | | | | | |
| | CO2: Understand the basic concepts of graph traversal methods | X | | | | | |
| | CO3: Apply various algorithm designing techniques for a given problem | | X | | | | |
| | CO4: Comprehend the basic concepts of trees and hashing techniques | | X | | | | |
| | CO5: Understand NP complete and NP hard problems | X | | | | | |
| Operating Systems (ICT 2254) | CO1: Acquire detailed understanding of operating system functionalities | X | | | | | |
| | CO2: Apply the knowledge to solve issues in process as well as memory management | | X | | | | |
| | CO3: Able to understand the fundamental concepts of real time operating | X | | | | | |
| | CO4: Apply the knowledge to understand modern operating systems concepts | X | | | | | |
| Algorithms Lab (ICT 2261) | CO1: Implement an algorithm to find path between any two vertices in the given graph | X | | | | | |
| | CO2: Apply the knowledge of shortest path algorithms for real world problems. | | | X | | | |
| | CO3: Implement Greedy, Divide and Conquer, Dynamic Programming, Back tracking and Branch and Bound techniques to solve different problems. | | | X | | | |
| | CO4: Implement approximation algorithm for travelling sales person and vertex cover problem. | | | X | | | |
| Microprocessor Systems Lab (ICT 2262) | CO1: Use assembly language development tool | X | | | | | |
| | CO2: Extend the knowledge of instruction set for writing efficient programs | X | | | | | |
| | CO3: Use subroutine concepts in programming | | X | | | | |
| | CO4: Write the programs using DOS interrupts | | X | | | | |
| | CO5: Apply the knowledge of advanced screen processing concepts | | X | | | | |
| Operating Systems Lab (ICT 2263) | CO1: Understand the working of UNIX based operating system | X | | | | | |
| | CO2: Illustrate the process management in operating systems. | X | | | | | |
| | CO3: Implement CPU scheduling as well as synchronization algorithms. | | | X | | | |
| | CO4: Implement algorithms used to understand the functionality of modern operating systems. | | | X | | | |

| Course (name and code) | Course/paper learning outcomes | Metaprofile Custer | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| Essentials of Management (HUM 3052) | CO1: Make comparisons of project alternatives during the planning and implementation phases | | | | X | | |
| | CO2: Determine the future value of a payment made in the present | | | | | X | |
| | CO3: Distinguish the present value of a payment to be made in the future | | | | | X | |
| | CO4: Estimate the future value of periodic payments | | | | | X | |
| | CO5: Compare and contrast the interest rate required on an investment to achieve a future sum | | | | | X | |
| | CO6 : Compute the annual worth of proposed alternatives | | | | X | | |
| | CO7 : Describe the best time to replace an aging asset | | | | X | | |
| | CO8: Explain the best method of depreciation to minimize tax liability | | | | X | | |
| Cyber Security (ICT 3151) Database Systems (ICT 3152) | CO1 :Understand the basics of cyber security. | | X | | | | |
| | CO2:Evaluate attacks on operating system, network and web. | | X | | | | |
| | CO3:Analyze the existing vulnerabilities and propose solutions. | | X | | | | |
| | CO4: Examine real case studies of cyber security incidents and their mitigation. | X | | | | | |
| | CO1: Understand the database concepts. | X | | | | | |
| | CO2: Apply procedural and non-procedural language constructs to manage database system | | X | | | | |
| | CO3: Design database using data modelling tool and normalization concepts | | X | | | | |
| | CO4: Describe transaction management and concurrency control concepts | X | | | | | |
| | CO5: Interpret the unstructured databases | X | | | | | |
| Embedded Systems (ICT 3153) | CO1: Familiarise with the salient features of embedded systems | X | | | | | |
| | CO2: Illustrate the architecture of ARM Cortex- M microcontroller | X | | | | | |
| | CO3: Familiarise with the efficient software design for embedded systems | | X | | | | |
| | CO4: Outline software development for ARM Cortex-M microcontroller | X | | | | | |
| | CO5 : Design real world systems using ARM Cortex-M microcontroller | | X | | | | |
| Software Engineering (ICT 3154) | CO1: Understand the basics of software development life cycle. | X | | | | | |
| | CO2: Understand the basic principles behind software configuration and risk management | X | | | | | |
| | CO3: Explore the importance of requirement analysis through scenario based exercise | X | | | | | |
| | CO4: Adapt software design strategies using object oriented concepts | X | | | | | |
| | CO5: Identify a suitable testing strategy to validate a given software application | | X | | | | |

| Course (name and code) | Course/paper learning outcomes | Metaprofile Custer | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| Database Systems Lab (ICT 3161) | CO1: Implement a graphical user interface (GUI) and access database through GUI using an integrated development environment.: | | | X | | | |
| | CO2: Design, create and query the relational database using structured query language. | | | X | | | |
| | CO3: Demonstrate the working of procedural and non-procedural language. | | | X | | | |
| | CO4: Perform create, read, update and delete operations on MongoDB | | | X | | | |
| | CO5 : Implement a mini project that provides solution to a real world problem. | | | X | X | | |
| Embedded Systems Lab (ICT 3162) | CO1: Recall the basics of an embedded system | X | | | | | |
| | CO2: Program an embedded system using ARM controller | X | | | | | |
| | CO3: Design, implement and test an embedded system. | | X | | | | |
| Network Programming and Simulation Lab (ICT 3163) | CO1: Implement client server socket programming | | | X | | | |
| | CO2: Simulate the network concepts using packet tracer. | | X | | | | |
| Engg. Economics and Financial Management (HUM 3051) | CO1: Understand the roles of mangers, principles of management, and managerial skills | | | | X | | |
| | CO2: Develop an organization structure and plan for manpower in a given business organization | | | | X | | |
| | CO3: Set objectives and propose strategies to accomplish them in a business | | | | X | | |
| | CO4: Apply leadership and motivational theories in the organizational context | | | | X | | |
| | CO5: Acquire budgetary skills | | X | | | | |
| | CO6: Understand the salient international business theories and practices | | | | X | | |
| | CO7: Prepare a business plan | | | | X | | |
| Data Warehousing and Data Mining (ICT 3251) | CO1: Apply pre-processing techniques on datasets | | X | | | | |
| | CO2: Describe the data warehouse architecture for facilitating querying | | X | | | | |
| | CO3: Identify data mining techniques and apply on datasets | | X | | | | |
| | CO4: Identify web mining techniques | | X | | | | |
| Distributed Systems (ICT 3252) | CO1: Understand basic concepts of distributed systems | X | | | | | |
| | CO2: Understand various techniques used for communication between distributed systems | X | | | | | |
| | CO3: Analyze the requirements for designing distributed file system and shared memory | X | | | | | |
| | CO4: Understand the issues pertaining to coordination, consistency, fault tolerance for a distributed system | X | | | | | |
| | CO5: Identify the concepts of distributed system to design any distributed application | X | | | | | |

| Course (name and code) | Course/paper learning outcomes | Metaprofile Custer | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| Advanced Technology Lab (ICT 3261) | CO1: Recognize the emerging technology used in the software industry | | | X | | | |
| | CO2: Construct the database that interacts with the application | | | X | | | |
| | CO3: Develop the GUI for the application | | | X | | | |
| | CO4: Select the appropriate tools and techniques to implement application | | | X | X | | |
| Data Warehousing and Data Mining Lab (ICT 3262) | CO1: Identify suitable pre-processing techniques for various dataset | | X | | | | |
| | CO2: Develop data warehouse | X | | | | | |
| | CO3: Apply suitable data mining technique on preprocessed data | | X | | | | |
| Internet Tools and Technology Lab (ICT 3263) | CO1: Design and develop dynamic web pages with good aesthetic sense of designing and latest technical know-how's | | | X | | | |
| | CO2: Have a good understanding of Web Application Terminologies, Internet Tools other web services | | | X | | | |
| | CO3: Understand and implement the client and server side programming for a Web application using latest tools | | | X | X | | |
| Industrial Training (ICT 4298) | CO1: Be acquainted with working environment at the Software Industries. | | | | X | | |
| | CO2:Be acquainted with processes that are in place at the Software Industries. | | | X | | | |
| | CO3:Familiarize the challenges as Software professionals. | | | | | | X |
| | CO4:Effectively write a technical report. | | | X | | | |
| Project Work / Practice School (ICT 4299) | CO1: Identify real world problems in the field of information and communication technology. | | | | | | X |
| | CO2: Design methodologies with implementation. | | X | | X | | |
| | CO3: Write technical report | | | | X | | |
| | CO4: Communicate effectively. | | | | X | | |

# 9

# Internal Quality Control/Enhancement

The feedback is taken from academia and industry experts regarding the effectiveness of the programme.

Department Curriculum Committee (DCC) and Board of Studies (BoS) comprises of experts from academia and industry, will be involved in analyzing feedback and deciding on the further improvements.

In order to meet the changing needs of IT industry, minor curriculum revision can be incorporated every semester after it is approved by the Department Curriculum Committee (DCC) and Board of Studies (BoS) . Major revision happens every 4 years. During this curriculum conclave is conducted to take inputs from various stakeholders. Current students are provided with an opportunity to present their dream curriculum. The feedback taken from academia, students, alumni and industry experts regarding the effectiveness of the programme is then put forward to Department Curriculum Committee (DCC) , Board of Studies (BoS) and Academic Council for approval.

Course articulation matrix is created for each course. Which gives the correlation levels for each CO to PO.

The correlation levels 1, 2 or 3 is defined as follows:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No correlation

Below is the sample course articulation matrix for the course MAT2155.

A program articulation matrix is created which maps each course with one or more POs. Sample table for program articulation matrix is given below.

| Course | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MAT 2105 | 3 | 3 | — | 3 | — | — | — | — | — | — | — | — | 3 | — | — |
| ICT2251 | 1 | 2 | 3 | 1 | 2 | — | 3 | — | — | 2 | 1 | — | 1 | 2 | 1 |
| ICT 2252 | — | 3 | — | — | 3 | — | — | — | — | 3 | 1 | 3 | 1 | 3 | 2 |
| ICT2253 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | — | — | — | 3 | — | 2 | 1 | 1 |
| ICT2254 | 1 | 3 | — | 2 | 1 | — | 3 | — | — | 1 | 1 | — | 2 | 1 | 2 |
| ICT2261 | 2 | 2 | 1 | 2 | 1 | — | 1 | — | — | 2 | 1 | — | 1 | 1 | 2 |
| ICT2262 | 3 | 3 | 3 | 1 | 2 | 1 | 1 | — | — | — | — | — | 2 | 2 | 2 |
| ICT 3151 | 3 | 3 | 3 | — | 3 | 2 | 2 | 3 | 3 | — | 3 | 3 | 3 | 1 | — |
| ICT 3152 | 1 | 1 | 3 | 2 | — | — | — | — | — | — | 2 | 3 | — | 3 | 1 |
| ICT 3153 | 1 | 3 | 1 | 1 | 1 | — | — | — | — | — | — | — | 2 | 3 | 1 |
| ICT 3154 | 2 | 2 | 3 | 1 | — | — | — | — | — | — | — | — | 3 | 3 | — |
| ICT 3161 | 3 | — | 2 | — | 2 | — | 2 | 1 | 2 | 3 | 3 | 1 | 3 | 3 | — |
| ICT3162 | 2 | 2 | 2 | — | — | — | — | — | — | — | — | — | 2 | 3 | — |
| ICT 3251 | 3 | 2 | 1 | 1 | 1 | — | — | — | — | 1 | 1 | 3 | 2 | — | 3 |
| ICT 3252 | 3 | 3 | 2 | 3 | — | — | — | — | — | — | — | 3 | 2 | 2 | 1 |
| ….. | …. | …. | …. | …. | …. | …. | …. | …. | …. | | | | | | |
| …… | ….. | …. | …. | …. | …. | …. | …. | | | | | | | | |

PO Assessment process for direct assessment is as given below:

Courses that contribute to program outcome are identified from the Program Articulation Matrix.

For each course that contribute to a particular program outcome, weightage $W_i$ is assigned based on the importance and Normalized Attainment Index (NAI) is calculated.

Program Outcome (PO) Attainment Index (AI) using the direct assessment is calculated by adding the NAI's of all the subjects mapped to a PO.

Below table shows PO attainment computed.

| Course | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO01 | PSO02 | PSO03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PO Attainment | 0.74 | 0.70 | 0.70 | 0.69 | 0.74 | 0.76 | 0.75 | 0.79 | 0.81 | 0.74 | 0.72 | 0.75 | 0.65 | 0.68 | 0.69 |

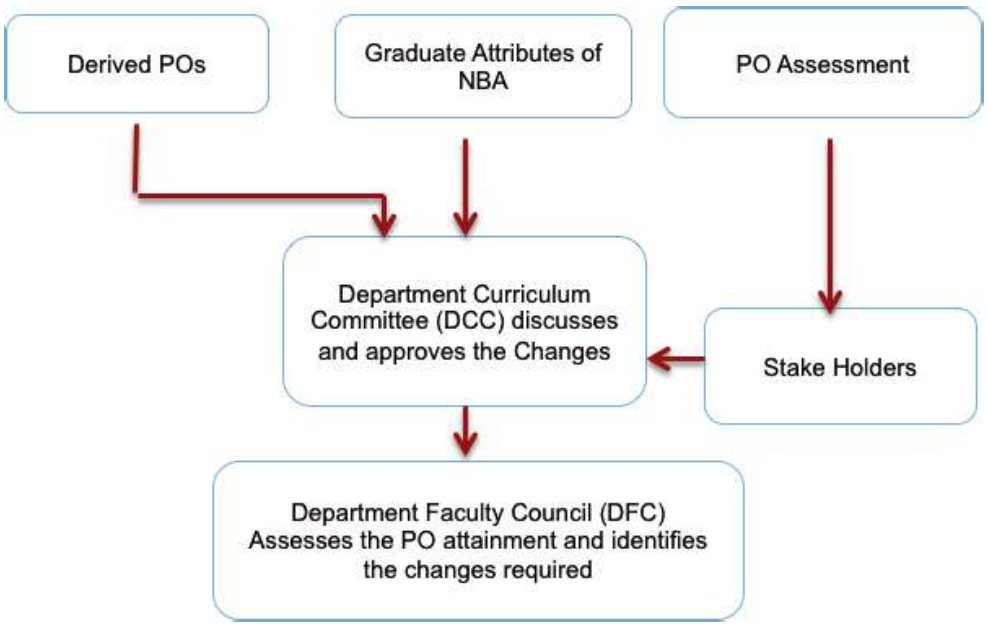
For each program outcome, performance indicators (Assessment criteria) and their targets are defined as shown below.

| PO Attainment Index (AI) Rubric | | | | |
|---|---|---|---|---|
| particulars | Excellent | Very Good | Satisfactory | Needs improvements |
| PO Attainment | >= 75 | >=70 | >=65 | < 65 |

| Analysis of PO attainment (Direct) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| 0.74 | 0.70 | 0.70 | 0.69 | 0.74 | 0.76 | 0.75 | 0.79 | 0.81 | 0.74 | 0.72 | 0.75 | 0.65 | 0.68 | 0.69 |
| Very Good | Very Good | Very Good | Satis-factory | Very Good | Excel-lent | Excel-lent | Excel-lent | Excel-lent | Very Good | Very Good | Excel-lent | Satis-factory | Satis-factory | Satis-factory |

If the assessed data meets the performance targets which are specified in the previous step, the outcome is attained. Otherwise, the Department Curriculum Committee (DCC) refines content delivery methods/course outcomes/curriculum improvements as needed.

The flow chart for the same is depicted below.



# 10

# Other Relevant Aspects

The program is (re) designed as per the guidelines and processes of the University.

11

# Example of Students' Learning Guide

## Bachelor in Technology in Information Technology

### Students' Learning Guide

Course: Neural Networks and Fuzzy Logic

Degree: Information Technology

3rd Year, Second Semester, 2019-2020

Code: ICT 4012

Language: English; Elective course (3 Credit)

Instructor: Sanjay Singh

Department of Information and Communication Technology, MIT Manipal

Students' Learning Guide Template

## I. Introduction to the Subject: Neural Networks and Fuzzy Logic (3rd Year, 2nd Term)

1.1. *Lecturer's contact details*

Sanjay Singh; Office no.:#30 (1st Floor, AB5); T/0820-2925386; Email: sanjay.singh@manipal.edu

**Tutorial (Office) hours:** Thursday from 9-10 am, and Friday from 2-3 pm or by appointment via email.

1.2. *Contribution to the degree profile*

This subject contributes to the academic and professional profile of the Degree of B.Tech (Information Technology). It is an elective course and a compulsory elective for students specializing in Soft Computing as minors. This subject is essential for the students to equip themselves with the mathematical formalism of neural networks and fuzzy logic. This subject provides the sufficient background to work in the area of deep learning. The intended Learning Outcomes of this subject are: understanding of conceptual issues behind the working of neural networks based systems; clarity on the conceptual issues behind the working of a fuzzy logic based system; using mathematical tools to design neural network based system for the given application; using mathematical tools to design fuzzy logic based system for the given problem. The skills acquired in this course are adequate to take up research and real-life problems in the area of deep neural network, machine learning and artificial intelligence.

1.3. *Competences to be developed*

Specific Competences

S.C.1: Applying knowledge of mathematical principles, algorithm and computer sciences to identify requirements, define, analyse and solve problems.

S.C.5: Design ICT systems, including modelling (formal description) of their structure and processes

Generic Competences

G.C.1: Ability to do research

G.C.4: Ability to apply knowledge in practical situations

## II. Student Work Plan

2.1. *Distribution of activities and workload*

| Competence | Contents | Activities-Resources-Documentation | Estimated work time | | Completion and/or submission deadlines |
|---|---|---|---|---|---|
| | | | Contact hours | Independent work | |
| G.C.1: Ability to do research<br>G.C.2: Ability to apply knowledge in practical situations<br>S.C.1: Applying knowledge of mathematical principles, algorithm and computer sciences to identify requirements, define, analyse and solve problems<br>S.C.5: Design ICT systems, including modelling (formal description) of their structure and processes | **UNIT 1: Introduction to neural networks and learning processes** | All materials/resources will appear within square brackets throughout the document. The [Text] are the obligatory assigned text, [PPT] refers to Power Point Presentations by the instructor, which can be found on Piazza under resource tab. | **UNIT 1 (11)** | **UNIT 1 (15)** | **3 Jan to 24th Jan**<br>**Week 1** |
| | | **Lecturer INTRODUCES the subject: programme, students' guide, degree profile**<br>[UNIT ONE: PDF document on Piazza] | **1 hour** | | |
| | | **Students REFLECT on introduction and profile.** | | **2 hours** | |
| | | **Lecturer INTRODUCES the Generic Competence: indicators, descriptors, etc** | **30 min** | | |
| | | **Students REFLECT on Generic Competence.** | | **30 mins** | |
| | | **"FEEDBACK" from teacher. (Group tutorial in class and individual tutorials)** | | | |
| | 1. Introduction to neural networks | **Lecturer INTRODUCES the basic concepts of neural networks**<br>[UNIT ONE: Introduction, PPT on Piazza] | **1 hour** | **30 mins**<br>**30 mins** | **Week 1** |
| | 2. Neural model and activation function | **Lecture by instructor**<br>[UNIT ONE: Simulation demo on bias] | **1 hour**<br>**30 min** | **30 min**<br>**30 min** | **Week 2** |
| | 3. Network Architecture | **Lecture by instructor**<br>[UNIT ONE: PDF handouts on Piazza] | **1 hour** | **1 hour** | |
| | | **"FEEDBACK" from teacher (individual tutorial)** | **30 min** | **30 min** | |
| | 4. Knowledge representation and design of neural netorks | **Lecture by instructor**<br>[UNIT ONE: PDF handout on Piazza] | **1 hour** | **1 hour** | **Week 2** |
| | | **Students reflect on the problems on neural network design** | | **1 hour** | |
| | 5. Introduction to learning process | **Lecture by instructor** | **1 hour** | **1 hour** | **Week 3** |
| | | [UNIT ONE: Assignment#1] | **20 min** | **20 min** | |
| | | [UNIT ONE: discussion and solution of assignment #1] | **40 min** | | |

| Competence | Contents | Activities-Resources-Documentation | Estimated work time | | Completion and/or submission deadlines |
|---|---|---|---|---|---|
| | | | Contact hours | Independent work | |
| | 6. Hebbian and other learning techniques | **Lecture by instructor**<br>[UNIT ONE: PDF handouts on Piazza]<br>Students reflect on various types of learning algorithms<br>"FEEDBACK" from teacher (both group and individual tutorial) | **1 hour**<br><br><br><br>**30 min** | **2 hour**<br>**30 min** | **Week 3** |
| | 7. Learning task and memory matrix | **Lecture by instructor**<br>[UNIT ONE: Practice problems] | **1 hour** | **1 hour**<br>**2 hour** | |
| G.C.1: Ability to do research | **UNIT 2: Perceptron, regression modeling, and LMS** | | **UNIT 2 (8)** | **UNIT 2 (15)** | **27 Jan to 13 Feb** |
| G.C.2: Ability to apply knowledge in practical situations | 1. Introduction to perceptron | **Lecture by instructor**<br>[UNIT TWO: PDF handouts on Piazza]<br>[UNIT TWO: Chapter 3 from Simon Haykin's book] | **1 hour** | **1 hour**<br>**1 hour** | **Week 4** |
| S.C.1: Applying knowledge of mathematical principles, algorithm and computer sciences to identify requirements, define, analyse and solve problems | 2. Bayes classifier as linear classifier | **Lecture by instructor**<br>[UNIT TWO: PDF handouts on Piazza]<br>[UNIT TWO: Chapter 3 from Simon Haykin's book]<br>**'Feedback' from teacher (individual tutorial)** | **1 hour**<br><br><br>**30 min** | **2 hour**<br><br><br>**30 min** | **Week 5** |
| S.C.5: Design ICT systems, including modelling (formal description) of their structure and processes | 3. Regression modeling | **Lecture by instructor**<br>[UNIT TWO: PDF handout on Piazza]<br>[UNIT TWO: Chapter on modeling through regression from Simon Haykin's book]<br>**'Feedback' from teacher (individual tutorial)** | **1 hour**<br><br><br>**30 min** | **1 hour**<br><br>**1 hour**<br>**30 min** | **Week 6** |
| | 4. Introduction to LMS algorithm | **Lecture by instructor**<br>[UNIT TWO: PDF handouts on Piazza]<br>[UNIT TWO: Chapter on LMS algorithm from Simon Haykin's book] | **1 hour** | **2 hour** | |
| | 5. Optimization method: Gradient descent, Newton's method, Gauss-Newton's method | **Lecture by instructor**<br>[UNIT TWO: PDF handouts on Piazza] | **1 hour** | **90 min** | |

| Competence | Contents | Activities-Resources-Documentation | Estimated work time | | Completion and/or submission deadlines |
|---|---|---|---|---|---|
| | | | Contact hours | Independent work | |
| | 6. LMS algorithm and its limitation | **Lecture by instructor**<br>[UNIT TWO: PDF handouts on Piazza]<br>[UNIT TWO: Practice problem on LMS algorithm from Hagan's book]<br>**[First Sessional Exam]**<br>[UNIT TWO: Assignment#2]<br>**"Feedback" from teacher on sessional exam and assignment #2 performance (group tutorial)** | **1 hour**<br>**20 min**<br>**1 hour** | **1 hour**<br><br>**1 hour**<br>**20min**<br>**1 hour** | |
| G.C.1: Ability to do research | **UNIT 3: Multilayer perceptron** | | **UNIT 3 (3)** | **UNIT 3 (6)** | **14 Feb to 28 Feb** |
| G.C.2: Ability to apply knowledge in practical situations | 1. Introduction to multilayer perceptron | **Lecture by instructor**<br>[UNIT THREE: PDF handouts on Piazza]<br>[UNIT THREE: Chapter on MLP from Simon Haykin's book] | **1 hour** | **1 hour**<br>**30 mins**<br>**1 hour** | **Week 7** |
| S.C.1: Applying knowledge of mathematical principles, algorithm and computer sciences to identify requirements, define, analyse and solve problems | 2. Problems based on backpropagation algorithm | **Lecture by instructor on problem solving on backpropagation** | **1 hour** | **2 hour** | **Week 8** |
| S.C.5: Design ICT systems, including modelling (formal description) of their structure and processes | 3. BPA algorithm and heuristics to improve its performance | **Lecture by instructor**<br>[UNIT THREE: PDF handouts on Piazza]<br>[UNIT THREE: Practice problems from Hagan's book]<br>**"Feedback" from teacher (individual tutorial)** | **1 hour**<br>**30 mins** | **1 hour**<br>**30 mins**<br>**30 mins** | |
| G.C.1: Ability to do research | **UNIT 4: Radial basis function network** | | **UNIT 4 (2)** | **UNIT 4 (5)** | **29 Feb to 7 March** |
| G.C.2: Ability to apply knowledge in practical situations | | | | | |
| S.C.1: Applying knowledge of mathematical principles, algorithm and computer sciences to identify requirements, define, analyse and solve problems | 1. Introduction to radial basis function network | **Lecture by instructor**<br>[UNIT FOUR: PDF handouts on Piazza]<br>[UNIT FOUR: Chapter on RBFN from Simon Haykin's book] | **1 hour** | **1 hour**<br>**30 mins**<br>**1 hour** | **Week 9** |
| S.C.5: Design ICT systems, including modelling (formal description) of their structure and processes | 2. Interpolation problem, RBFN, solving XOR problem using RBFN | Lecture by instructor<br>[UNIT FOUR: Practice problems on RBFN from Hagan's book]<br>"Feedback" from teacher<br>(individual tutorial) | **1 hour**<br><br>**30 mins** | **1 hour**<br>**1 hour**<br><br>**30 mins** | |

| Competence | Contents | Activities-Resources-Documentation | Estimated work time | | Completion and/or submission deadlines |
|---|---|---|---|---|---|
| | | | Contact hours | Independent work | |
| G.C.1: Ability to do research | **UNIT 5: Support vector machine** | | **UNIT 5 (4)** | **UNIT 5 (10)** | **9 March to 16 March** |
| G.C.2: Ability to apply knowledge in practical situations | 1. Introduction to support vector machine | **Lecture by instructor**<br>[UNIT FIVE: PDF handouts on Piazza]<br>[UNIT FIVE: Chapter on SVM from Simon Haykin's book]<br>[UNIT FIVE: Assignment# 3] | **1 hour**<br>**20 mins** | **2 hour**<br>**30 mins**<br>**20 mins** | |
| S.C.1: Applying knowledge of mathematical principles, algorithm and computer sciences to identify requirements, define, analyse and solve problems | 2. Optimal hyperplane for linear classification | **Lecture by instructor**<br>[UNIT FIVE: PDF handouts on Piazza] | **1 hour** | **2 hour** | |
| | 3. Optimal hyperplane for non-linear case | **Lecture by instructor**<br>[UNIT FIVE: PDF handouts on Piazza] | **1 hour** | **1 hour**<br>**30 mins** | **Week 10** |
| S.C.5: Design ICT systems, including modelling (formal description) of their structure and processes | 4. SVM with kernels and XOR problem | **Lecture by instructor**<br>[UNIT FIVE: PDF handouts on Piazza]<br>[UNIT FIVE: Practice problem from Hagan's book]<br>**"Feedback" from teacher (individual tutorial)** | **1 hour**<br>**30 mins** | **2 hour**<br>**30 mins**<br>**1 hour**<br>**30 mins** | |
| G.C.1: Ability to do research | **UNIT 6: Fuzzy logic** | | **UNIT 6 (11)** | **UNIT 6 (20)** | **17 March to 17 April** |
| G.C.2: Ability to apply knowledge in practical situations | 1. Classical sets and fuzzy sets | **Lecture by instructor**<br>[UNIT SIX: PDF handouts on Piazza]<br>[UNIT SIX: Chapter on classical and fuzzy sets from Timothy Ross's book]<br>[UNIT SIX: Practice problems from Ross's book]<br>**"Feedback" from teacher (individual tutorial)** | **1 hour**<br>**30 mins** | **1 hour**<br>**30 mins**<br>**1 hour**<br>**1 hour**<br>**30 mins** | |
| S.C.1: Applying knowledge of mathematical principles, algorithm and computer sciences to identify requirements, define, analyse and solve problems | | | | | |
| S.C.5: Design ICT systems, including modelling (formal description) of their structure and processes | 2. Classical relations and fuzzy relations | **Lecture by instructor**<br>[UNIT SIX: PDF handouts on Piazza]<br>[UNIT SIX: Chapter on classical and fuzzy relations from Timothy Ross's book]<br>[UNIT SIX: Practice problems from Ross's book]<br>**"Feedback" from teacher (individual tutorial)** | **1 hour**<br>**30 mins** | **1 hour**<br>**30 mins**<br>**1 hour**<br>**1 hour**<br>**30 mins** | |

| Competence | Contents | Activities-Resources-Documentation | Estimated work time | | Completion and/or submission deadlines |
|---|---|---|---|---|---|
| | | | Contact hours | Independent work | |
| | 3. Properties of membership function and defuzzification | **Lecture by instructor**<br>[UNIT SIX: PDF handouts on Piazza]<br>[UNIT SIX: Chapter on membership function and defuzzyfication from Timothy Ross's book]<br>[UNIT SIX: Practice problems from Ross's book]<br>**'Feedback' from teacher (individual tutorial)** | **1 hour**<br><br><br><br><br>**30 mins** | **2 hour**<br>**30 mins**<br>**1 hour**<br><br>**1 hour**<br><br>**30 mins** | |
| | 4. Logic and fuzzy systems | **Lecture by instructor**<br>[UNIT SIX: PDF handouts on Piazza]<br>[UNIT SIX: Chapter on logica and fuzzy systems from Timothy Ross's book]<br>[UNIT SIX: Practice problems from Ross's book]<br>**"Feedback" from teacher (individual tutorial)**<br>**[Second Sessional Examination]**<br>**"Feedback" from teacher (in class both group and individual tutorial)** | **1 hour**<br><br><br><br>**30 mins**<br>**1 hour**<br>**1 hour** | **2 hour**<br>**30 mins**<br>**1 hour**<br><br>**1 hour**<br><br>**30 mins**<br>**1 hour**<br>**1 hour** | |
| | 5. Development of fuzzy systems | **Lecture by instructor**<br>[UNIT SIX: PDF handouts on Piazza]<br>[UNIT SIX: Chapter on development of fuzzy system from Timothy Ross's book]<br>[UNIT SIX: Practice problems from Ross's book]<br>[UNIT SIX: Assignment #4]<br>**"Feedback" from teacher (in class tutorial)** | **1 hour**<br><br><br><br>**20 mins**<br>**40 mins** | **1 hour**<br>**30 mins**<br>**1 hour**<br><br>**1 hour**<br>**20 mins** | |
| | 6. Neuro-fuzzy systems | **Lecture by instructor**<br>[UNIT SIX: PDF handouts on Piazza]<br>[UNIT SIX: Practice problems from Ross's book] | **1 hour** | **2 hour**<br>**30 mins**<br>**2 hour** | |
| | | ***Total*** | **39 hours** | **71 hours** | |

2.2. *Summary*

| Type of activities | Contact hours | Independent work | Total |
|---|---|---|---|
| Theoretical learning | 36 hours | 32 hours | 68 hours |
| Practical activities and assessment | 9.2 hours | 6.2 hours | 15.4 hours |
| ***Total*** | **45.2 hours** | **38.2 hours** | **83.4 hours** |

## III. Assessment System

3.1. *Table of assessment*

| Competence | Assessment technique | Grade |
|---|---|---|
| **Generic competence 1**<br>G.C.1: Ability to do research<br><br>**Learning Outcomes**<br>• LO1: Student reads, and comprehend a research paper in the area of neuro-fuzzy system<br>• LO2: Student formulates a research problem given a scenario | • **3 minute theses**<br>• **Four assignments**<br>• **Two short mid-term tests**<br>• **Final exam**<br><br>**Three minute theses-**students are asked to choose a research paper of their choice in the area of neuro-fuzzy system. They are required to read, comprehend and convey the idea of the research paper within 3MT format. However, this exercise is optional to the students. They can either choose a regular assignment or a 3MT exercise.<br><br>**For the four assignments-**students are given assignment sheet on a previously covered topic. They are given 20 mins to solve the problems, and it is an open book test to assess their comprehension of the concept for a practical scenario.<br><br>**For the two short-midterm test-**students appear for close book test for one hour<br><br>**For the final exam:** students appear for a close book written test for three hour duration | **20%**<br><br>**30%**<br><br>**50%** |
| **Generic competence 2**<br>G.C.2: Ability to apply knowledge in practical situations<br><br>**Learning Outcomes**<br>• LO1. Student will be able to identify a learning paradigm for a given practical problem<br>• LO2. Student will be able to suggest a suitable neural network architecture for a given practical problem<br>• LO3. Student will be able to identify the required fuzzy concepts for a practical situation | | |
| **Specific competence 1**<br>S.C.1: Applying knowledge of mathematical principles, algorithm and computer sciences to identify requirements, define, analyse and solve problems<br><br>**Learning Outcomes**<br>• LO1. Student will be able to use the mathematical tools and algorithms for neural networks to solve a given problem<br>• LO2. Student will be able to use mathematical tools and concepts for fuzzy logic to solve a given practical situation<br>• LO3. Student will be able to analyze a given neuro-fuzzy situation | | |
| **Specific competence 2**<br>S.C.5: Design ICT systems, including modelling (formal description) of their structure and processes<br><br>**Learning Outcomes**<br>• LO1. Student will be able to model a given problem for neural network design<br>• LO2. Student will be able to model a given problem for fuzzy system design<br>• LO3. Student will be able to formally model a neuro-fuzzy ssytem | | |

3.2. *Observations of assessment*

3.3. *Summary of assessment*

| Competence | Continuous assessment | Final assessment | Total |
|---|---|---|---|
| G.C.1: Ability to do research | **3MT (optional 10%) or Assignments (10%)** | 0% | 10% |
| G.C.2: Ability to apply knowledge in practical situations | **Assignments (10%)** | 10% | 20% |
| S.C.1: Applying knowledge of mathematical principles, algorithm and computer sciences to identify requirements, define, analyse and solve problems | **Assignments and midterm test (15%)** | 20% | 35% |
| S.C.5: Design ICT systems, including modelling (formal description) of their structure and processes | **Assignments and midterm test (15%)** | 20% | 35% |
| ***Total*** | **50%** | **50%** | **100%** |

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