



**ANNA UNIVERSITY, CHENNAI
NON- AUTONOMOUS AFFILIATED COLLEGES
REGULATIONS 2021**

CHOICE BASED CREDIT SYSTEM

B.TECH. COMPUTER SCIENCE AND BUSINESS SYSTEMS

I. PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

- I. To ensure graduates will be proficient in utilizing the fundamental knowledge of basic sciences, mathematics, Computer Science and Business systems for the applications relevant to various streams of Engineering and Technology.
- II. To enrich graduates with the core competencies necessary for applying knowledge of computer science and Data analytics tools to store, retrieve, implement and analyze data in the context of business enterprise
- III. To enable graduates to gain employment in organizations and establish themselves as professionals by applying their technical skills and leadership qualities to solve real world problems and meet the diversified needs of industry, academia and research
- IV. To equip the graduates with entrepreneurial skills and qualities which help them to perceive the functioning of business, diagnose business problems, explore the entrepreneurial opportunities and prepare them to manage business efficiently.

II. PROGRAM OUTCOMES (POs)

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

solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

- 8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- 9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- 10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- 11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- 12 **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

III. PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: To create, select, and apply appropriate techniques, resources, modern engineering and business tools including prediction and data analytics to complex engineering activities and business solutions

PSO2: To evolve computer science domain specific methodologies for effective decision making in several critical problem domains of the real world.

PSO3: To be able to apply entrepreneurial skills and management tools for identifying, analyzing and creating business opportunities with smart business ideas.

PSO4: To manage complex IT projects with consideration of the human, financial, ethical and environmental factors and an understanding of risk management processes, and operational and policy implications

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REGULATIONS 2021
B.TECH. COMPUTER SCIENCE AND BUSINESS SYSTEMS
CHOICE BASED CREDIT SYSTEM
CURRICULA FOR SEMESTERS I TO VIII AND SYLLABI FOR SEMESTERS III AND IV
SEMESTER I

| S. NO. | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|-------------------|-------------|---|-----------|------------------|----------|-----------|-----------------------|-----------|
| | | | | L | T | P | | |
| 1. | IP3151 | Induction Programme | - | - | - | - | - | 0 |
| THEORY | | | | | | | | |
| 2. | HS3151 | Professional English - I | HSMC | 3 | 0 | 0 | 3 | 3 |
| 3. | MA3151 | Matrices and Calculus | BSC | 3 | 1 | 0 | 4 | 4 |
| 4. | PH3151 | Engineering Physics | BSC | 3 | 0 | 0 | 3 | 3 |
| 5. | CY3151 | Engineering Chemistry | BSC | 3 | 0 | 0 | 3 | 3 |
| 6. | GE3151 | Problem Solving and Python Programming | ESC | 3 | 0 | 0 | 3 | 3 |
| 7. | GE3152 | அறிவியல் தமிழ் /Scientific Thoughts in Tamil | HSMC | 1 | 0 | 0 | 1 | 1 |
| PRACTICALS | | | | | | | | |
| 8. | GE3171 | Problem Solving and Python Programming Laboratory | ESC | 0 | 0 | 4 | 4 | 2 |
| 9. | BS3171 | Physics and Chemistry Laboratory | BSC | 0 | 0 | 4 | 4 | 2 |
| 10. | GE3172 | English Laboratory [§] | EEC | 0 | 0 | 2 | 2 | 1 |
| TOTAL | | | | 16 | 1 | 10 | 27 | 22 |

[§] Skill Based Course

SEMESTER II

| S. NO. | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|-------------------|-------------|--|-----------|------------------|----------|-----------|-----------------------|-----------|
| | | | | L | T | P | | |
| THEORY | | | | | | | | |
| 1. | HS3251 | Professional English - II | HSMC | 2 | 0 | 0 | 2 | 2 |
| 2. | MA3251 | Statistics and Numerical Methods | BSC | 3 | 1 | 0 | 4 | 4 |
| 3. | PH3256 | Physics for Information Science | BSC | 3 | 0 | 0 | 3 | 3 |
| 4. | BE3251 | Basic Electrical and Electronics Engineering | ESC | 3 | 0 | 0 | 3 | 3 |
| 5. | GE3251 | Engineering Graphics | ESC | 2 | 0 | 4 | 6 | 4 |
| 6. | AD3251 | Data Structures Design | PCC | 3 | 0 | 0 | 3 | 3 |
| 7. | GE3252 | தமிழர் மரபு /Heritage of Tamils | HSMC | 1 | 0 | 0 | 1 | 1 |
| 8. | | NCC Credit Course Level 1 [#] | - | 2 | 0 | 0 | 2 | 2* |
| PRACTICALS | | | | | | | | |
| 9. | GE3271 | Engineering Practices Laboratory | ESC | 0 | 0 | 4 | 4 | 2 |
| 10. | AD3271 | Data Structures Design Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 11. | GE3272 | Communication Laboratory / Foreign Language [§] | EEC | 0 | 0 | 4 | 4 | 2 |
| TOTAL | | | | 17 | 1 | 16 | 34 | 26 |

[#] NCC Credit Course level 1 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

[§] Skill Based Course

SEMESTER III

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|-------------------|-------------|--|-----------|------------------|----------|-----------|-----------------------|-----------|
| | | | | L | T | P | | |
| THEORY | | | | | | | | |
| 1. | MA3354 | Discrete Mathematics | BSC | 3 | 1 | 0 | 4 | 4 |
| 2. | CS3351 | Digital Principles and Computer Organization | ESC | 3 | 0 | 2 | 5 | 4 |
| 3. | CW3301 | Fundamentals of Economics | PCC | 3 | 0 | 0 | 3 | 3 |
| 4. | CS3391 | Object Oriented Programming | PCC | 3 | 0 | 0 | 3 | 3 |
| 5. | AD3351 | Design and Analysis of Algorithms | PCC | 3 | 0 | 2 | 5 | 4 |
| 6. | AD3491 | Fundamentals of Data science and Analytics | PCC | 3 | 0 | 0 | 3 | 3 |
| PRACTICALS | | | | | | | | |
| 7. | CW3311 | Business Communication Laboratory I | PCC | 0 | 0 | 3 | 3 | 1.5 |
| 8. | CS3381 | Object Oriented Programming Laboratory | PCC | 0 | 0 | 3 | 3 | 1.5 |
| 9. | GE3361 | Professional Development [§] | EEC | 0 | 0 | 2 | 2 | 1 |
| TOTAL | | | | 18 | 1 | 12 | 31 | 25 |

[§] Skill Based Course

SEMESTER IV

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|-------------------|-------------|---|-----------|------------------|----------|-----------|-----------------------|----------------|
| | | | | L | T | P | | |
| THEORY | | | | | | | | |
| 1. | MA3391 | Probability and Statistics | BSC | 3 | 1 | 0 | 4 | 4 |
| 2. | CS3492 | Database Management Systems | PCC | 3 | 0 | 0 | 3 | 3 |
| 3. | AL3452 | Operating Systems | PCC | 3 | 0 | 2 | 5 | 4 |
| 4. | CW3401 | Introduction to Business Systems | PCC | 3 | 0 | 0 | 3 | 3 |
| 5. | AL3451 | Machine Learning | PCC | 3 | 0 | 0 | 3 | 3 |
| 6. | GE3451 | Environmental Sciences and Sustainability | BSC | 2 | 0 | 0 | 2 | 2 |
| 7. | | NCC Credit Course Level 2 [#] | | 3 | 0 | 0 | 3 | 3 [#] |
| PRACTICALS | | | | | | | | |
| 8. | CS3481 | Database Management Systems Laboratory | PCC | 0 | 0 | 3 | 3 | 1.5 |
| 9. | AL3461 | Machine Learning Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 10. | CW3411 | Business Communication Laboratory II | PCC | 0 | 0 | 3 | 3 | 1.5 |
| TOTAL | | | | 17 | 1 | 12 | 30 | 24 |

[#] NCC Credit Course level 2 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

SEMESTER V

| S. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|-------------------|-------------|-------------------------------------|----------|------------------|---|---|-----------------------|-----------|
| | | | | L | T | P | | |
| THEORY | | | | | | | | |
| 1. | CS3691 | Embedded Systems and IoT | PCC | 3 | 0 | 2 | 5 | 4 |
| 2. | CW3501 | Fundamentals of Management | PCC | 3 | 0 | 0 | 3 | 3 |
| 3. | CW3551 | Data and Information Security | PCC | 3 | 0 | 0 | 3 | 3 |
| 4. | | Professional Elective I | PEC | - | - | - | - | 3 |
| 5. | | Professional Elective II | PEC | - | - | - | - | 3 |
| 6. | | Mandatory Course-I ^{&} | MC | 3 | 0 | 0 | 3 | 0 |
| PRACTICALS | | | | | | | | |
| 7. | CW3511 | Summer internship | EEC | 0 | 0 | 0 | 0 | 2 |
| TOTAL | | | | - | - | - | - | 18 |

[&] Mandatory Course-I is a Non-credit Course (Student shall select one course from the list given under Mandatory Course-I)

SEMESTER VI

| S. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|-------------------|-------------|--|----------|------------------|---|---|-----------------------|----------------|
| | | | | L | T | P | | |
| THEORY | | | | | | | | |
| 1. | CCW331 | Business Analytics | PCC | 2 | 0 | 2 | 4 | 3 |
| 2. | CCS356 | Object Oriented Software Engineering | PCC | 3 | 0 | 2 | 5 | 4 |
| 3. | | Open Elective – I* | OEC | 3 | 0 | 0 | 3 | 3 |
| 4. | | Professional Elective III | PEC | - | - | - | - | 3 |
| 5. | | Professional Elective IV | PEC | - | - | - | - | 3 |
| 6. | | Professional Elective V | PEC | - | - | - | - | 3 |
| 7. | | Professional Elective VI | PEC | - | - | - | - | 3 |
| 8. | | Mandatory Course-II ^{&} | MC | 3 | 0 | 0 | 3 | 0 |
| 9. | | NCC Credit Course Level 3 [#] | | 3 | 0 | 0 | 3 | 3 [#] |
| PRACTICALS | | | | | | | | |
| 10. | CW3611 | Business Analytics Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| TOTAL | | | | - | - | - | - | 24 |

*Open Elective – I Shall be chosen from the list of open electives offered by other Programmes

[&] Mandatory Course-II is a Non-credit Course (Student shall select one course from the list given under Mandatory Course-II)

[#] NCC Credit Course level 3 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA

SEMESTER VII / VIII*

| S. NO | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---------------|-------------|------------------------------------|-----------|------------------|----------|----------|-----------------------|-----------|
| | | | | L | T | P | | |
| THEORY | | | | | | | | |
| 1. | GE3791 | Human Values and Ethics | HSMC | 2 | 0 | 0 | 2 | 2 |
| 2. | | Elective - Management [#] | HSMC | 3 | 0 | 0 | 3 | 3 |
| 3. | | Open Elective – II** | OEC | 3 | 0 | 0 | 3 | 3 |
| 4. | | Open Elective – III** | OEC | 3 | 0 | 0 | 3 | 3 |
| 5. | | Open Elective – IV** | OEC | 3 | 0 | 0 | 3 | 3 |
| TOTAL | | | | 14 | 0 | 0 | 14 | 14 |

*If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.

** Open Elective II - IV (Shall be chosen from the list of open electives offered by other Programmes).

Elective - Management shall be chosen from the Elective Management courses.

SEMESTER VIII / VII*

| S. NO | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|-------------------|-------------|---------------------------|-----------|------------------|----------|-----------|-----------------------|-----------|
| | | | | L | T | P | | |
| PRACTICALS | | | | | | | | |
| 1. | CW3811 | Project Work / Internship | EEC | 0 | 0 | 20 | 20 | 10 |
| TOTAL | | | | 0 | 0 | 20 | 20 | 10 |

*If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.

TOTAL CREDITS :163

ELECTIVE – MANAGEMENT COURSES

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PERWEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|--------|-------------|--|-----------|-----------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | GE3751 | Principles of Management | HSMC | 3 | 0 | 0 | 3 | 3 |
| 2. | GE3752 | Total Quality Management | HSMC | 3 | 0 | 0 | 3 | 3 |
| 3. | GE3753 | Engineering Economics and Financial Accounting | HSMC | 3 | 0 | 0 | 3 | 3 |
| 4. | GE3754 | Human Resource Management | HSMC | 3 | 0 | 0 | 3 | 3 |
| 5. | GE3755 | Knowledge Management | HSMC | 3 | 0 | 0 | 3 | 3 |
| 6. | GE3792 | Industrial Management | HSMC | 3 | 0 | 0 | 3 | 3 |

MANDATORY COURSES I

| S. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|--------|-------------|--|----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | MX3081 | Introduction to Women and Gender Studies | MC | 3 | 0 | 0 | 3 | 0 |
| 2. | MX3082 | Elements of Literature | MC | 3 | 0 | 0 | 3 | 0 |
| 3. | MX3083 | Film Appreciation | MC | 3 | 0 | 0 | 3 | 0 |
| 4. | MX3084 | Disaster Management | MC | 3 | 0 | 0 | 3 | 0 |

MANDATORY COURSES II

| S. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|--------|-------------|---|----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | MX3085 | Well Being with traditional practices (Yoga, Ayurveda and Siddha) | MC | 3 | 0 | 0 | 3 | 0 |
| 2. | MX3086 | History of Science and Technology in India | MC | 3 | 0 | 0 | 3 | 0 |
| 3. | MX3087 | Political and Economic Thought for a Humane Society | MC | 3 | 0 | 0 | 3 | 0 |
| 4. | MX3088 | State, Nation Building and Politics in India | MC | 3 | 0 | 0 | 3 | 0 |
| 5. | MX3089 | Industrial Safety | MC | 3 | 0 | 0 | 3 | 0 |

PROFESSIONAL ELECTIVE COURSES: VERTICALS

| Vertical I Data Science | Vertical II Cloud Computing and Data Centre Technologies | Vertical III Emerging Technologies | Vertical IV Artificial Intelligence and Machine Learning | Vertical V Management | Vertical VI Marketing |
|------------------------------------|---|---|---|--|---|
| Exploratory Data Analysis | Cloud Computing | Augmented Reality/Virtual Reality | Knowledge Engineering | Customer Relation Management | Financial Analytics |
| Recommender Systems | Virtualization | Robotic Process Automation | Soft Computing | Human Resource Management for Entrepreneurs | Recommender Systems |
| Neural Networks and Deep Learning | Cloud Services Management | Neural Networks and Deep Learning | Neural Networks and Deep Learning | Financial Management | Digital Marketing |
| Text and Speech Analysis | Data Warehousing | Cyber security | Text and Speech Analysis | Supply Chain Management | Conversational Systems |
| Business Analytics | Storage Technologies | Quantum Computing | Optimization Techniques | IT Project Management | Social Text and Media Analytics |
| Image and video analytics | Software Defined Networks | Cryptocurrency and Blockchain Technologies | Game Theory | Entrepreneurship Development | Marketing Research and Marketing Management |
| Computer Vision | Stream Processing | Game Development | Cognitive Science | Introduction to Innovation, IP Management and Entrepreneurship | Risk Analytics |
| Big Data Analytics | Security and Privacy in Cloud | 3D Printing and Design | Ethics And AI | Behavioral economics | Enterprise Security |

Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered in Semesters V and VI. These courses are listed in groups called verticals that represent a particular area of specialisation / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, two courses are permitted from the same row, provided one course is enrolled in Semester V and another in semester VI.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E./B.Tech (Honours) or Minor degree also. For more details on B.E./B.Tech (Honours) or Minor degree refer to the Regulations 2021, Clause 4.10.

PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTICAL 1: DATA SCIENCE

| S. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|--------|-------------|-----------------------------------|----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | CCS346 | Exploratory Data Analysis | PEC | 2 | 0 | 2 | 4 | 3 |
| 2. | CCS360 | Recommender Systems | PEC | 2 | 0 | 2 | 4 | 3 |
| 3. | CCS355 | Neural Networks and Deep Learning | PEC | 2 | 0 | 2 | 4 | 3 |
| 4. | CCS369 | Text and Speech Analysis | PEC | 2 | 0 | 2 | 4 | 3 |
| 5. | CCW331 | Business Analytics | PEC | 2 | 0 | 2 | 4 | 3 |
| 6. | CCS349 | Image and video analytics | PEC | 2 | 0 | 2 | 4 | 3 |
| 7. | CCS338 | Computer Vision | PEC | 2 | 0 | 2 | 4 | 3 |
| 8. | CCS334 | Big Data Analytics | PEC | 2 | 0 | 2 | 4 | 3 |

VERTICAL 2: CLOUD COMPUTING AND DATA CENTRE TECHNOLOGIES

| S. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|--------|-------------|-------------------------------|----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | CCS335 | Cloud Computing | PEC | 2 | 0 | 2 | 4 | 3 |
| 2. | CCS372 | Virtualization | PEC | 2 | 0 | 2 | 4 | 3 |
| 3. | CCS336 | Cloud Services Management | PEC | 2 | 0 | 2 | 4 | 3 |
| 4. | CCS341 | Data Warehousing | PEC | 2 | 0 | 2 | 4 | 3 |
| 5. | CCS367 | Storage Technologies | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CCS365 | Software Defined Networks | PEC | 2 | 0 | 2 | 4 | 3 |
| 7. | CCS368 | Stream Processing | PEC | 2 | 0 | 2 | 4 | 3 |
| 8. | CCS362 | Security and Privacy in Cloud | PEC | 2 | 0 | 2 | 4 | 3 |

VERTICAL 3: EMERGING TECHNOLOGIES

| S. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|--------|-------------|--|----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | CCS333 | Augmented Reality/Virtual Reality | PEC | 2 | 0 | 2 | 4 | 3 |
| 2. | CCS361 | Robotic Process Automation | PEC | 2 | 0 | 2 | 4 | 3 |
| 3. | CCS355 | Neural Networks and Deep Learning | PEC | 2 | 0 | 2 | 4 | 3 |
| 4. | CCS340 | Cyber security | PEC | 2 | 0 | 2 | 4 | 3 |
| 5. | CCS359 | Quantum Computing | PEC | 2 | 0 | 2 | 4 | 3 |
| 6. | CCS339 | Cryptocurrency and Blockchain Technologies | PEC | 2 | 0 | 2 | 4 | 3 |
| 7. | CCS347 | Game Development | PEC | 2 | 0 | 2 | 4 | 3 |
| 8. | CCS331 | 3D Printing and Design | PEC | 2 | 0 | 2 | 4 | 3 |

VERTICAL 4: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

| S. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|--------|-------------|-----------------------------------|----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | CCS350 | Knowledge Engineering | PEC | 2 | 0 | 2 | 4 | 3 |
| 2. | CCS364 | Soft Computing | PEC | 2 | 0 | 2 | 4 | 3 |
| 3. | CCS355 | Neural Networks and Deep Learning | PEC | 2 | 0 | 2 | 4 | 3 |
| 4. | CCS369 | Text and Speech Analysis | PEC | 2 | 0 | 2 | 4 | 3 |
| 5. | CCS357 | Optimization Techniques | PEC | 2 | 0 | 2 | 4 | 3 |
| 6. | CCS348 | Game Theory | PEC | 2 | 0 | 2 | 4 | 3 |
| 7. | CCS337 | Cognitive Science | PEC | 2 | 0 | 2 | 4 | 3 |
| 8. | CCS345 | Ethics And AI | PEC | 2 | 0 | 2 | 4 | 3 |

VERTICAL 5: MANAGEMENT

| S. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|--------|-------------|--|----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | CW3003 | Customer Relation Management | PEC | 2 | 0 | 2 | 4 | 3 |
| 2. | CMG341 | Human Resource Management for Entrepreneurs | PEC | 2 | 0 | 2 | 4 | 3 |
| 3. | CCD332 | Financial Management | PEC | 2 | 0 | 2 | 4 | 3 |
| 4. | CCD334 | Supply Chain Management | PEC | 2 | 0 | 2 | 4 | 3 |
| 5. | CW3007 | IT Project Management | PEC | 2 | 0 | 2 | 4 | 3 |
| 6. | CW3005 | Entrepreneurship Development | PEC | 2 | 0 | 2 | 4 | 3 |
| 7. | CW3006 | Introduction to Innovation, IP Management and Entrepreneurship | PEC | 2 | 0 | 2 | 4 | 3 |
| 8. | CW3001 | Behavioral economics | PEC | 2 | 0 | 2 | 4 | 3 |

VERTICAL 6: MARKETING

| S. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|--------|-------------|---|----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | CMG354 | Financial Analytics | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CCS360 | Recommender Systems | PEC | 2 | 0 | 2 | 4 | 3 |
| 3. | CCW332 | Digital Marketing | PEC | 2 | 0 | 2 | 4 | 3 |
| 4. | CW3002 | Conversational Systems | PEC | 2 | 0 | 2 | 4 | 3 |
| 5. | CW3009 | Social Text and Media Analytics | PEC | 2 | 0 | 2 | 4 | 3 |
| 6. | CCB331 | Marketing Research and Marketing Management | PEC | 2 | 0 | 2 | 4 | 3 |
| 7. | CW3008 | Risk Analytics | PEC | 2 | 0 | 2 | 4 | 3 |
| 8. | CW3004 | Enterprise Security | PEC | 2 | 0 | 2 | 4 | 3 |

OPEN ELECTIVES

(Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories).

OPEN ELECTIVES – I

| S. NO. | COURSE ODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|--------|------------|--|-----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | OAS351 | Space Science | OEC | 3 | 0 | 0 | 3 | 3 |
| 2. | OIE351 | Introduction to Industrial Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 3. | OBT351 | Climate Change and its Impact | OEC | 3 | 0 | 0 | 3 | 3 |
| 4. | OCE351 | Environment and Social Impact Assessment | OEC | 3 | 0 | 0 | 3 | 3 |
| 5. | OEE351 | Renewable Energy System | OEC | 3 | 0 | 0 | 3 | 3 |
| 6. | OEI351 | Introduction to Industrial Instrumentation and Control | OEC | 3 | 0 | 0 | 3 | 3 |
| 7. | OMA351 | Graph Theory | OEC | 3 | 0 | 0 | 3 | 3 |

OPEN ELECTIVES – II

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|--------|-------------|-------------------------------------|-----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | OIE352 | Resource Management Techniques | OEC | 3 | 0 | 0 | 3 | 3 |
| 2. | OMG351 | Fintech Regulations | OEC | 3 | 0 | 0 | 3 | 3 |
| 3. | OFD351 | Holistic Nutrition | OEC | 3 | 0 | 0 | 3 | 3 |
| 4. | OCE352 | ICT in Agriculture | OEC | 3 | 0 | 0 | 3 | 3 |
| 5. | OEI352 | Introduction to Control Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 6. | OPY351 | Pharmaceutical Nanotechnology | OEC | 3 | 0 | 0 | 3 | 3 |
| 7. | OAE351 | Aviation Management | OEC | 3 | 0 | 0 | 3 | 3 |

OPEN ELECTIVES – III

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|--------|-------------|--------------------------------------|-----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | OHS351 | English for Competitive Examinations | OEC | 3 | 0 | 0 | 3 | 3 |
| 2. | OMG352 | NGOs and Sustainable Development | OEC | 3 | 0 | 0 | 3 | 3 |
| 3. | OMG353 | Democracy and Good Governance | OEC | 3 | 0 | 0 | 3 | 3 |

| | | | | | | | | |
|-----|--------|---|-----|---|---|---|---|---|
| 4. | OME353 | Renewable Energy Technologies | OEC | 3 | 0 | 0 | 3 | 3 |
| 5. | OME354 | Applied Design Thinking | OEC | 2 | 0 | 2 | 4 | 3 |
| 6. | OMF351 | Reverse Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 7. | OMF353 | Sustainable Manufacturing | OEC | 3 | 0 | 0 | 3 | 3 |
| 8. | OAU351 | Electric and Hybrid Vehicle | OEC | 3 | 0 | 0 | 3 | 3 |
| 9. | OAS352 | Space Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 10. | OIM351 | Industrial Management | OEC | 3 | 0 | 0 | 3 | 3 |
| 11. | OIE354 | Quality Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 12. | OSF351 | Fire Safety Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 13. | OML351 | Introduction to non-destructive testing | OEC | 3 | 0 | 0 | 3 | 3 |
| 14. | OMR351 | Mechatronics | OEC | 3 | 0 | 0 | 3 | 3 |
| 15. | ORA351 | Foundation of Robotics | OEC | 3 | 0 | 0 | 3 | 3 |
| 16. | OAE352 | Fundamentals of Aeronautical engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 17. | OGI351 | Remote Sensing Concepts | OEC | 3 | 0 | 0 | 3 | 3 |
| 18. | OAI351 | Urban Agriculture | OEC | 3 | 0 | 0 | 3 | 3 |
| 19. | OEN351 | Drinking Water Supply and Treatment | OEC | 3 | 0 | 0 | 3 | 3 |
| 20. | OEE352 | Electric Vehicle technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 21. | OEI353 | Introduction to PLC Programming | OEC | 3 | 0 | 0 | 3 | 3 |
| 22. | OCH351 | Nano Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 23. | OCH352 | Functional Materials | OEC | 3 | 0 | 0 | 3 | 3 |
| 24. | OBT352 | Biomedical Instrumentation | OEC | 3 | 0 | 0 | 3 | 3 |
| 25. | OFD352 | Traditional Indian Foods | OEC | 3 | 0 | 0 | 3 | 3 |
| 26. | OFD353 | Introduction to food processing | OEC | 3 | 0 | 0 | 3 | 3 |
| 27. | OPY352 | IPR for Pharma Industry | OEC | 3 | 0 | 0 | 3 | 3 |
| 28. | OTT351 | Basics of Textile Finishing | OEC | 3 | 0 | 0 | 3 | 3 |
| 29. | OTT352 | Industrial Engineering for Garment Industry | OEC | 3 | 0 | 0 | 3 | 3 |
| 30. | OTT353 | Basics of Textile Manufacture | OEC | 3 | 0 | 0 | 3 | 3 |
| 31. | OPE351 | Introduction to Petroleum Refining and Petrochemicals | OEC | 3 | 0 | 0 | 3 | 3 |
| 32. | OPE352 | Energy Conservation and Management | OEC | 3 | 0 | 0 | 3 | 3 |
| 33. | OPT351 | Basics of Plastics Processing | OEC | 3 | 0 | 0 | 3 | 3 |
| 34. | OEC351 | Signals and Systems | OEC | 3 | 0 | 0 | 3 | 3 |
| 35. | OEC352 | Fundamentals of Electronic Devices and Circuits | OEC | 3 | 0 | 0 | 3 | 3 |
| 36. | OBM351 | Foundation Skills in integrated product Development | OEC | 3 | 0 | 0 | 3 | 3 |
| 37. | OBM352 | Assistive Technology | OEC | 3 | 0 | 0 | 3 | 3 |

| | | | | | | | | |
|-----|--------|------------------------------------|-----|---|---|---|---|---|
| 38. | OMA352 | Operations Research | OEC | 3 | 0 | 0 | 3 | 3 |
| 39. | OMA353 | Algebra and Number Theory | OEC | 3 | 0 | 0 | 3 | 3 |
| 40. | OMA354 | Linear Algebra | OEC | 3 | 0 | 0 | 3 | 3 |
| 41. | OCE353 | Lean Concepts, Tools And Practices | OEC | 3 | 0 | 0 | 3 | 3 |

OPEN ELECTIVES – IV

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---------|-------------|--|-----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | OHS352 | Project Report Writing | OEC | 3 | 0 | 0 | 3 | 3 |
| 2. | OMA355 | Advanced Numerical Methods | OEC | 3 | 0 | 0 | 3 | 3 |
| 3. | OMA356 | Random Processes | OEC | 3 | 0 | 0 | 3 | 3 |
| 4. | OMA357 | Queuing and Reliability Modelling | OEC | 3 | 0 | 0 | 3 | 3 |
| 5. | OMG354 | Production and Operations Management for Entrepreneurs | OEC | 3 | 0 | 0 | 3 | 3 |
| 6. | OMG355 | Multivariate Data Analysis | OEC | 3 | 0 | 0 | 3 | 3 |
| 7. | OME352 | Additive Manufacturing | OEC | 3 | 0 | 0 | 3 | 3 |
| 8. | OME353 | New Product Development | OEC | 3 | 0 | 0 | 3 | 3 |
| 9. | OME355 | Industrial Design & Rapid Prototyping Techniques | OEC | 2 | 0 | 2 | 4 | 3 |
| 10. | OMF352 | Micro and Precision Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 11. | OMF354 | Cost Management of Engineering Projects | OEC | 3 | 0 | 0 | 3 | 3 |
| 12. | OAU352 | Batteries and Management system | OEC | 3 | 0 | 0 | 3 | 3 |
| 13. | OAU353 | Sensors and Actuators | OEC | 3 | 0 | 0 | 3 | 3 |
| 14. | OAS353 | Space Vehicles | OEC | 3 | 0 | 0 | 3 | 3 |
| 15. | OIM352 | Management Science | OEC | 3 | 0 | 0 | 3 | 3 |
| 16. | OIM353 | Production Planning and Control | OEC | 3 | 0 | 0 | 3 | 3 |
| 17. | OIE353 | Operations Management | OEC | 3 | 0 | 0 | 3 | 3 |
| 18. | OSF352 | Industrial Hygiene | OEC | 3 | 0 | 0 | 3 | 3 |
| 19. | OSF353 | Chemical Process Safety | OEC | 3 | 0 | 0 | 3 | 3 |
| 20. | OML352 | Electrical, Electronic and Magnetic materials | OEC | 3 | 0 | 0 | 3 | 3 |
| 21. | OML353 | Nanomaterials and applications | OEC | 3 | 0 | 0 | 3 | 3 |
| 22. | OMR352 | Hydraulics and Pneumatics | OEC | 3 | 0 | 0 | 3 | 3 |
| 23. | OMR353 | Sensors | OEC | 3 | 0 | 0 | 3 | 3 |
| 24. | ORA352 | Foundation of Automation | OEC | 3 | 0 | 0 | 3 | 3 |
| 25. | ORA353 | Concepts in Mobile | OEC | 3 | 0 | 0 | 3 | 3 |

| | | | | | | | | |
|-----|--------|---|-----|---|---|---|---|---|
| | | Robotics | | | | | | |
| 26. | OMV351 | Marine Propulsion | OEC | 3 | 0 | 0 | 3 | 3 |
| 27. | OMV352 | Marine Merchant Vehicles | OEC | 3 | 0 | 0 | 3 | 3 |
| 28. | OMV353 | Elements of Marine Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 29. | OAE353 | Drone Technologies | OEC | 3 | 0 | 0 | 3 | 3 |
| 30. | OGI352 | Geographical Information System | OEC | 3 | 0 | 0 | 3 | 3 |
| 31. | OAI352 | Agriculture Entrepreneurship Development | OEC | 3 | 0 | 0 | 3 | 3 |
| 32. | OEN352 | Biodiversity Conservation | OEC | 3 | 0 | 0 | 3 | 3 |
| 33. | OEE353 | Introduction to control systems | OEC | 3 | 0 | 0 | 3 | 3 |
| 34. | OEI354 | Introduction to Industrial Automation Systems | OEC | 3 | 0 | 0 | 3 | 3 |
| 35. | OCH353 | Energy Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 36. | OCH354 | Surface Science | OEC | 3 | 0 | 0 | 3 | 3 |
| 37. | OBT353 | Environment and Agriculture | OEC | 3 | 0 | 0 | 3 | 3 |
| 38. | OFD354 | Fundamentals of Food Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 39. | OFD355 | Food safety and Quality Regulations | OEC | 3 | 0 | 0 | 3 | 3 |
| 40. | OPY353 | Nutraceuticals | OEC | 3 | 0 | 0 | 3 | 3 |
| 41. | OTT354 | Basics of Dyeing and Printing | OEC | 3 | 0 | 0 | 3 | 3 |
| 42. | OTT355 | Fibre Science | OEC | 3 | 0 | 0 | 3 | 3 |
| 43. | OTT356 | Garment Manufacturing Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 44. | OPE353 | Industrial safety | OEC | 3 | 0 | 0 | 3 | 3 |
| 45. | OPE354 | Unit Operations in Petro Chemical Industries | OEC | 3 | 0 | 0 | 3 | 3 |
| 46. | OPT352 | Plastic Materials for Engineers | OEC | 3 | 0 | 0 | 3 | 3 |
| 47. | OPT353 | Properties and Testing of Plastics | OEC | 3 | 0 | 0 | 3 | 3 |
| 48. | OEC353 | VLSI Design | OEC | 3 | 0 | 0 | 3 | 3 |
| 49. | OEC354 | Industrial IoT and Industry 4.0 | OEC | 2 | 0 | 2 | 4 | 3 |
| 50. | OBM353 | Wearable devices | OEC | 3 | 0 | 0 | 3 | 3 |
| 51. | OBM354 | Medical Informatics | OEC | 3 | 0 | 0 | 3 | 3 |
| 52. | OCE354 | Basics of Integrated Water Resources Management | OEC | 3 | 0 | 0 | 3 | 3 |

SUMMARY

| Name of the Programme: B.Tech. Computer Science and Business Systems | | | | | | | | | | |
|--|----------------------------|----------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|---------------|
| S.No | Subject Area | Credits per Semester | | | | | | | | Total Credits |
| | | I | II | III | IV | V | VI | VII/VIII | VIII/VII | |
| 1 | HSMC | 4 | 3 | | | | | 5 | | 12 |
| 2 | BSC | 12 | 7 | 4 | 6 | | | | | 29 |
| 3 | ESC | 5 | 9 | 4 | | | | | | 18 |
| 4 | PCC | | 5 | 16 | 18 | 10 | 9 | | | 58 |
| 5 | PEC | | | | | 6 | 12 | | | 18 |
| 6 | OEC | | | | | | 3 | 9 | | 12 |
| 7 | EEC | 1 | 2 | 1 | | 2 | | | 10 | 16 |
| 8 | Non-Credit /(Mandatory) | | | | | | ✓ | ✓ | | |
| Total | | 22 | 26 | 25 | 24 | 18 | 24 | 14 | 10 | 163 |

ENROLLMENT FOR B.E. / B. TECH. (HONOURS) / MINOR DEGREE (OPTIONAL)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E. / B. Tech. (Honours) or Minor Degree.

For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes, Moreover, for minor degree the student can register for courses from any one of the following verticals also.

Complete details are available in clause 4.10 of Regulations 2021.

VERTICALS FOR MINOR DEGREE
(In addition to all the verticals of other programmes)

| Vertical I Fintech and Block Chain | Vertical II Entrepreneurship | Vertical III Public Administration | Vertical IV Business Data Analytics | Vertical V Environmental and Sustainability |
|---|--|---|--|--|
| Financial Management | Foundations of Entrepreneurship | Principles of Public Administration | Statistics for Management | Sustainable infrastructure Development |
| Fundamentals of Investment | Team Building & Leadership Management for Business | Constitution of India | Datamining for Business Intelligence | Sustainable Agriculture and Environmental Management |
| Banking, Financial Services and Insurance | Creativity & Innovation in Entrepreneurship | Public Personnel Administration | Human Resource Analytics | Sustainable Bio Materials |
| Introduction to Blockchain and its Applications | Principles of Marketing Management For Business | Administrative Theories | Marketing and Social Media Web Analytics | Materials for Energy Sustainability |
| Fintech Personal Finance and Payments | Human Resource Management for Entrepreneurs | Indian Administrative System | Operation and Supply Chain Analytics | Green Technology |
| Introduction to Fintech | Financing New Business Ventures | Public Policy Administration | Financial Analytics | Environmental Quality Monitoring and Analysis |
| - | - | - | - | Integrated Energy Planning for Sustainable Development |
| - | - | - | - | Energy Efficiency for Sustainable Development |

(choice of courses for Minor degree is to be made from any one vertical of other programmes or from anyone of the following verticals)

VERTICAL 1: FINTECH AND BLOCK CHAIN

| S. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|--------|-------------|---|----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | CMG331 | Financial Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CMG332 | Fundamentals of Investment | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CMG333 | Banking, Financial Services and Insurance | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CMG334 | Introduction to Blockchain and its Applications | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CMG335 | Fintech Personal Finance and Payments | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CMG336 | Introduction to Fintech | PEC | 3 | 0 | 0 | 3 | 3 |

VERTICAL 2: ENTREPRENEURSHIP

| S. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|--------|-------------|--|----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | CMG337 | Foundations of Entrepreneurship | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CMG338 | Team Building & Leadership Management for Business | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CMG339 | Creativity & Innovation in Entrepreneurship | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CMG340 | Principles of Marketing Management for Business | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CMG341 | Human Resource Management for Entrepreneurs | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CMG342 | Financing New Business Ventures | PEC | 3 | 0 | 0 | 3 | 3 |

VERTICAL 3: PUBLIC ADMINISTRATION

| S. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|--------|-------------|-------------------------------------|----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | CMG343 | Principles of Public Administration | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CMG344 | Constitution of India | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CMG345 | Public Personnel Administration | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CMG346 | Administrative Theories | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CMG347 | Indian Administrative System | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CMG348 | Public Policy Administration | PEC | 3 | 0 | 0 | 3 | 3 |

VERTICAL 4: BUSINESS DATA ANALYTICS

| S. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|--------|-------------|--|----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | CMG349 | Statistics for Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CMG350 | Datamining For Business Intelligence | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CMG351 | Human Resource Analytics | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CMG352 | Marketing and Social Media Web Analytics | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CMG353 | Operation and Supply Chain Analytics | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CMG354 | Financial Analytics | PEC | 3 | 0 | 0 | 3 | 3 |

VERTICAL 5: ENVIRONMENTAL AND SUSTAINABILITY

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|--------|-------------|--|-----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | CES331 | Sustainable infrastructure Development | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CES332 | Sustainable Agriculture and Environmental Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CES333 | Sustainable Bio Materials | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CES334 | Materials for Energy Sustainability | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CES335 | Green Technology | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CES336 | Environmental Quality Monitoring and Analysis | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | CES337 | Integrated Energy Planning for Sustainable Development | PEC | 3 | 0 | 0 | 3 | 3 |
| 8. | CES338 | Energy Efficiency for Sustainable Development | PEC | 3 | 0 | 0 | 3 | 3 |

COURSE OBJECTIVES:

- To extend student's logical and mathematical maturity and ability to deal with abstraction.
- To introduce most of the basic terminologies used in computer science courses and application of ideas to solve practical problems.
- To understand the basic concepts of combinatorics and graph theory.
- To familiarize the applications of algebraic structures.
- To understand the concepts and significance of lattices and boolean algebra which are widely used in computer science and engineering.

UNIT I LOGIC AND PROOFS**9 + 3**

Propositional logic – Propositional equivalences - Predicates and quantifiers – Nested quantifiers – Rules of inference - Introduction to proofs – Proof methods and strategy.

UNIT II COMBINATORICS**9 + 3**

Mathematical induction – Strong induction and well ordering – The basics of counting – The pigeonhole principle – Permutations and combinations – Recurrence relations – Solving linear recurrence relations – Generating functions – Inclusion and exclusion principle and its applications.

UNIT III GRAPHS**9 + 3**

Graphs and graph models – Graph terminology and special types of graphs – Matrix representation of graphs and graph isomorphism – Connectivity – Euler and Hamilton paths.

UNIT IV ALGEBRAIC STRUCTURES**9 + 3**

Algebraic systems – Semi groups and monoids - Groups – Subgroups – Homomorphism's – Normal subgroup and cosets – Lagrange's theorem – Definitions and examples of Rings and Fields.

UNIT V LATTICES AND BOOLEAN ALGEBRA**9 + 3**

Partial ordering – Posets – Lattices as posets – Properties of lattices - Lattices as algebraic systems – Sub lattices – Direct product and homomorphism – Some special lattices – Boolean algebra – Sub Boolean Algebra – Boolean Homomorphism.

TOTAL: 60 PERIODS**COURSE OUTCOMES:**

At the end of the course, students would :

CO1:Have knowledge of the concepts needed to test the logic of a program.

CO2:Have an understanding in identifying structures on many levels.

CO3:Be aware of a class of functions which transform a finite set into another finite set which relates to input and output functions in computer science.

CO4:Be aware of the counting principles.

CO5:Be exposed to concepts and properties of algebraic structures such as groups, rings and fields.

UNIT V MEMORY AND I/O**9**

Memory Concepts and Hierarchy – Memory Management – Cache Memories: Mapping and Replacement Techniques – Virtual Memory – DMA – I/O – Accessing I/O: Parallel and Serial Interface – Interrupt I/O – Interconnection Standards: USB, SATA

45 PERIODS**30 PERIODS****PRACTICAL EXERCISES:**

1. Verification of Boolean theorems using logic gates.
2. Design and implementation of combinational circuits using gates for arbitrary functions.
3. Implementation of 4-bit binary adder/subtractor circuits.
4. Implementation of code converters.
5. Implementation of BCD adder, encoder and decoder circuits
6. Implementation of functions using Multiplexers.
7. Implementation of the synchronous counters
8. Implementation of a Universal Shift register.
9. Simulator based study of Computer Architecture

COURSE OUTCOMES:

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

CO1 : Design various combinational digital circuits using logic gates

CO2 : Design sequential circuits and analyze the design procedures

CO3 : State the fundamentals of computer systems and analyze the execution of an instruction

CO4 : Analyze different types of control design and identify hazards

CO5 : Identify the characteristics of various memory systems and I/O communication

TOTAL:75 PERIODS**TEXT BOOKS**

1. M. Morris Mano, Michael D. Ciletti, "Digital Design : With an Introduction to the Verilog HDL, VHDL, and System Verilog", Sixth Edition, Pearson Education, 2018.
2. David A. Patterson, John L. Hennessy, "Computer Organization and Design, The Hardware/Software Interface", Sixth Edition, Morgan Kaufmann/Elsevier, 2020.

REFERENCES

1. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Naraig Manjikian, "Computer Organization and Embedded Systems", Sixth Edition, Tata McGraw-Hill, 2012.
2. William Stallings, "Computer Organization and Architecture – Designing for Performance", Tenth Edition, Pearson Education, 2016.
3. M. Morris Mano, "Digital Logic and Computer Design", Pearson Education, 2016.

CW3301**FUNDAMENTALS OF ECONOMICS****L T P C****3 0 0 3****COURSE OBJECTIVES:**

- To exemplify the demand curves of households and supply curves of firms with the principles.
- To differentiate Price ceilings, Price floors and compare income effects, substitute effects
- To Analyze the Keynesian's process of multiplier theory in macro economics

UNIT I INTRODUCTION TO MICRO ECONOMICS 9

Introduction to Economics – Themes of Economics – Micro Vs Macro Economics- Demand curves and supply curves- Elasticity of Demand - Elasticity of Supply- Demand Curves of Households and firms

UNIT II WELFARE ANALYSIS 9

Consumers and Producers Surplus- Price Ceilings and Price Floors; Consumer Behavior - Axioms of Choice-Budget Constraints and Indifference Curves; Consumers Equilibrium Effects of a Price Change, Income and Substitution Effects Derivation of a Demand Curve

UNIT III PRODUCTION AND COST FUNCTION 9

Theory of Production - Production Function and Isoquants - Cost Minimization; Cost Curves - Total, Average and Marginal Costs - Long Run and Short Run Costs; Equilibrium of a Firm under Perfect Competition; Monopoly and Monopolistic Competition

UNIT IV MACRO ECONOMICS 9

National Income and its Components - GNP, NNP, GDP, NDP Consumption Function; Investment; Simple Keynesian Model of Income Determination and the Keynesian Multiplier; Government Sector -Taxes and Subsidies; External Sector - Exports and Imports; Money -Definitions; Demand for Money Transaction and Speculative Demand; Supply of Money - Banks Credit Creation Multiplier; Integrating Money and Commodity Markets - IS, LM Model

UNIT V BUSINESS CYCLES AND STABILIZATION 9

Monetary and Fiscal Policy - Central Bank and the Government; the Classical Paradigm - Price and Wage Rigidities - Voluntary and Involuntary Unemployment.

COURSE OUTCOMES:

CO1: To analyze the supporting of price, income and substitution effects in the consumers and producers surplus.

CO2: To compare the equilibrium of a firm under perfect competition, monopoly and monopolistic competition.

CO3 : To study the concepts of demand for money and supply of money with appropriate model in macro economic analysis.

CO4: To examine and evaluate the problems of voluntary and involuntary unemployment

TOTAL:45 PERIODS

TEXT BOOKS:

1. Paul Anthony Samuelson, William D. Nordhaus, Economics, Nineteenth Edition, McGraw-Hill Education, 2010.
2. N. Gregory Mankiw, Principles of Macroeconomics, Seventh Edition, Cengage Learning, 2018.
3. Pindyck, Robert S and Daniel L. Rubinfeld , Micro Economics, Eighth Edition, 2013.

REFERENCES

1. Dornbusch, Fischer and Startz, Macroeconomics, Tenth Edition, Tata Mcgraw Hill, 2012.

2. Hal R, Varia, Intermediate Microeconomics: A Modern Approach, Eighth Edition Affiliated East-West Press, 2006

CS3391

OBJECT ORIENTED PROGRAMMING

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand Object Oriented Programming concepts and basics of Java programming language
- To know the principles of packages, inheritance and interfaces
- To develop a java application with threads and generics classes
- To define exceptions and use I/O streams
- To design and build Graphical User Interface Application using JAVAFX

UNIT I INTRODUCTION TO OOP AND JAVA 9

Overview of OOP – Object oriented programming paradigms – Features of Object Oriented Programming – Java Buzzwords – Overview of Java – Data Types, Variables and Arrays – Operators – Control Statements – Programming Structures in Java – Defining classes in Java – Constructors-Methods -Access specifiers - Static members- JavaDoc comments

UNIT II INHERITANCE, PACKAGES AND INTERFACES 9

Overloading Methods – Objects as Parameters – Returning Objects –Static, Nested and Inner Classes. Inheritance: Basics– Types of Inheritance -Super keyword -Method Overriding – Dynamic Method Dispatch –Abstract Classes – final with Inheritance. Packages and Interfaces: Packages – Packages and Member Access –Importing Packages – Interfaces.

UNIT III EXCEPTION HANDLING AND MULTITHREADING 9

Exception Handling basics – Multiple catch Clauses – Nested try Statements – Java’s Built-in Exceptions – User defined Exception. Multithreaded Programming: Java Thread Model–Creating a Thread and Multiple Threads – Priorities – Synchronization – Inter Thread Communication- Suspending –Resuming, and Stopping Threads –Multithreading. Wrappers – Auto boxing.

UNIT IV I/O, GENERICS, STRING HANDLING 9

I/O Basics – Reading and Writing Console I/O – Reading and Writing Files. Generics: Generic Programming – Generic classes – Generic Methods – Bounded Types – Restrictions and Limitations. Strings: Basic String class, methods and String Buffer Class..

UNIT V JAVAFX EVENT HANDLING, CONTROLS AND COMPONENTS 9

JAVAFX Events and Controls: Event Basics – Handling Key and Mouse Events. Controls: Checkbox, ToggleButton – RadioButtons – ListView – ComboBox – ChoiceBox – Text Controls – ScrollPane. Layouts – FlowPane – HBox and VBox – BorderPane – StackPane – GridPane. Menus – Basics – Menu – Menu bars – MenuItem.

COURSE OUTCOMES:

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

- CO1:**Apply the concepts of classes and objects to solve simple problems
CO2:Develop programs using inheritance, packages and interfaces
CO3:Make use of exception handling mechanisms and multithreaded model to solve real world problems
CO4:Build Java applications with I/O packages, string classes, Collections and generics concepts
CO5:Integrate the concepts of event handling and JavaFX components and controls for developing GUI based applications

TOTAL:45 PERIODS

TEXT BOOKS

1. Herbert Schildt, “Java: The Complete Reference”, 11th Edition, McGraw Hill Education, New Delhi, 2019
2. Herbert Schildt, “Introducing JavaFX 8 Programming”, 1st Edition, McGraw Hill Education, New Delhi, 2015

REFERENCES:

1. Cay S. Horstmann, “Core Java Fundamentals”, Volume 1, 11th Edition, Prentice Hall, 2018.

| | | |
|---------------|--|----------------|
| AD3351 | DESIGN AND ANALYSIS OF ALGORITHMS | L T P C |
| | | 3 0 2 4 |

COURSE OBJECTIVES:

- To critically analyze the efficiency of alternative algorithmic solutions for the same problem
- To illustrate brute force and divide and conquer design techniques.
- To explain dynamic programming and greedy techniques for solving various problems.
- To apply iterative improvement technique to solve optimization problems
- To examine the limitations of algorithmic power and handling it in different problems.

UNIT I INTRODUCTION 8

Notion of an Algorithm – Fundamentals of Algorithmic Problem Solving – Important Problem Types –Fundamentals of the Analysis of Algorithm Efficiency – Analysis Framework - Asymptotic Notations and their properties – Empirical analysis - Mathematical analysis of Recursive and Non-recursive algorithms – Visualization.

UNIT II BRUTE FORCE AND DIVIDE AND CONQUER 10

Brute Force – String Matching - Exhaustive Search - Traveling Salesman Problem - Knapsack Problem - Assignment problem. Divide and Conquer Methodology – Multiplication of Large Integers and Strassen’s Matrix Multiplication – Closest-Pair and Convex - Hull Problems. Decrease and Conquer: - Topological Sorting – Transform and Conquer: Presorting – Heaps and Heap Sort.

UNIT III DYNAMIC PROGRAMMING AND GREEDY TECHNIQUE 10

Dynamic programming – Principle of optimality - Coin changing problem – Warshall’s and Floyd’s algorithms – Optimal Binary Search Trees - Multi stage graph - Knapsack Problem and Memory functions. Greedy Technique – Dijkstra’s algorithm - Huffman Trees and codes - 0/1 Knapsack problem.

UNIT IV ITERATIVE IMPROVEMENT

8

The Simplex Method-The Maximum-Flow Problem – Maximum Matching in Bipartite Graphs- The Stable marriage Problem.

UNIT V LIMITATIONS OF ALGORITHM POWER

9

Lower - Bound Arguments - P, NP, NP- Complete and NP Hard Problems. Backtracking – N-Queen problem - Hamiltonian Circuit Problem – Subset Sum Problem. Branch and Bound – LIFO Search and FIFO search - Assignment problem – Knapsack Problem – Traveling Salesman Problem - Approximation Algorithms for NP-Hard Problems – Traveling Salesman problem – Knapsack problem.

TOTAL: 45 PERIODS

PRACTICAL EXERCISES: (30 hrs)

1. Implement recursive and non-recursive algorithms and study the order of growth from $\log_2 n$ to $n!$.
2. Divide and Conquer - Strassen's Matrix Multiplication
3. Decrease and Conquer - Topological Sorting
4. Transform and Conquer - Heap Sort
5. Dynamic programming - Coin change Problem, Warshall's and Floyd's algorithms, Knapsack Problem
6. Greedy Technique – Dijkstra's algorithm, Huffman Trees and codes
7. Iterative improvement - Simplex Method
8. Backtracking – N-Queen problem, Subset Sum Problem
9. Branch and Bound - Assignment problem, Traveling Salesman Problem

COURSE OUTCOMES:

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

CO1: Analyze the efficiency of recursive and non-recursive algorithms mathematically

CO2: Analyze the efficiency of brute force, divide and conquer, decrease and conquer, Transform and conquer algorithmic techniques

CO3: Implement and analyze the problems using dynamic programming and greedy algorithmic techniques.

CO4: Solve the problems using iterative improvement techniques for optimization.

CO5: Compute the limitations of algorithmic power and solve the problems using backtracking and branch and bound techniques.

TOTAL: 75 PERIODS

TEXT BOOKS:

1. Anany Levitin, Introduction to the Design and Analysis of Algorithms, Third Edition, Pearson Education, 2012.

REFERENCES:

1. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, Computer Algorithms/ C++, Second Edition, Universities Press, 2019.

OUTCOMES:

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

- CO1: Explain the data analytics pipeline
- CO2: Describe and visualize data
- CO3 : Perform statistical inferences from data
- CO4 : Analyze the variance in the data
- CO5 : Build models for predictive analytics

TEXT BOOKS

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, "Introducing Data Science", Manning Publications, 2016. (first two chapters for Unit I).
2. Robert S. Witte and John S. Witte, "Statistics", Eleventh Edition, Wiley Publications, 2017.
3. Jake VanderPlas, "Python Data Science Handbook", O'Reilly, 2016.

REFERENCES

1. Allen B. Downey, "Think Stats: Exploratory Data Analysis in Python", Green Tea Press, 2014.
2. Sanjeev J. Wagh, Manisha S. Bhende, Anuradha D. Thakare, "Fundamentals of Data Science", CRC Press, 2022.
3. Chirag Shah, "A Hands-On Introduction to Data Science", Cambridge University Press, 2020.
4. Vineet Raina, Srinath Krishnamurthy, "Building an Effective Data Science Practice: A Framework to Bootstrap and Manage a Successful Data Science Practice", Apress, 2021.

CW3311

BUSINESS COMMUNICATION LABORATORY I

L T P C
0 0 3 1.5

COURSE OBJECTIVES:

- To enhance students' overall communication and their interpersonal skills by engaging them in group activities so that they could excel in their career pursuits.
- To improve the students' fluency level in the English language by enriching their diction and articulation so that they could effectively present themselves in their workplaces.

LIST OF EXPERIMENTS:

1. Business terminology
2. Interpersonal Skills: Dialogue & Conversation
3. Job Application
4. Letters & Reports
5. SWOT analysis
6. Team vs Group
7. Conflict management
8. Acquiring Leadership traits
9. Women in all spheres

10. Human values and Corporate culture

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1:Speak fluently in English without errors and present themselves as effective communicators.

CO2:Use business vocabulary and take part comfortably in business conversations in English.

CO3:Draft letters and reports with appropriate formats and choice of words.

CO4:Perform well in team and group, resolve conflicts in workplaces and acquire leadership skills.

CO5:Understand women in all spheres and cultural behaviours of the people and approach them with positive human values.

List of Equipments:(30 Students per Batch)

1: Systems with Rosetta stone and Globarena

REFERENCES:

1. Business Communication, Dr. Saroj Hire math
2. English vocabulary in use , Alan McCarthy and O'Dell
3. Strategic Writing by Charles Marsh
4. he Seven Basic Plots by Christopher Booker

CS3381

OBJECT ORIENTED PROGRAMMING LABORATORY

L T P C
0 0 3 1.5

COURSE OBJECTIVES

- To build software development skills using java programming for real-world applications.
- To understand and apply the concepts of classes, packages, interfaces, inheritance, exception handling and file processing.
- To develop applications using generic programming and event handling

LIST OF EXPERIMENTS

1. Solve problems by using sequential search, binary search, and quadratic sorting algorithms (selection, insertion)
2. Develop stack and queue data structures using classes and objects.
3. Develop a java application with an Employee class with Emp_name, Emp_id, Address, Mail_id, Mobile_no as members. Inherit the classes, Programmer, Assistant Professor, Associate Professor and Professor from employee class. Add Basic Pay (BP) as the member of all the inherited classes with 97% of BP as DA, 10 % of BP as HRA, 12% of BP as PF, 0.1% of BP for staff club funds. Generate pay slips for the employees with their gross and net salary.

4. Write a Java Program to create an abstract class named Shape that contains two integers and an empty method named printArea(). Provide three classes named Rectangle, Triangle and Circle such that each one of the classes extends the class Shape. Each one of the classes contains only the method printArea() that prints the area of the given shape.
5. Solve the above problem using an interface.
6. Implement exception handling and creation of user defined exceptions.
7. Write a java program that implements a multi-threaded application that has three threads. First thread generates a random integer every 1 second and if the value is even, the second thread computes the square of the number and prints. If the value is odd, the third thread will print the value of the cube of the number.
8. Write a program to perform file operations.
9. Develop applications to demonstrate the features of generics classes.
10. Develop applications using JavaFX controls, layouts and menus.
11. Develop a mini project for any application using Java concepts.

Lab Requirements: for a batch of 30 students

Operating Systems: Linux / Windows

Front End Tools: Eclipse IDE / Netbeans IDE

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Design and develop java programs using object oriented programming concepts

CO2 : Develop simple applications using object oriented concepts such as package, exceptions

CO4 : Create GUIs and event driven programming applications for real world problems

CO3: Implement multithreading, and generics concepts

CO5: Implement and deploy web applications using Java

MA3391

PROBABILITY AND STATISTICS

L T P C

3 1 0 4

COURSE OBJECTIVES

- This course aims at providing the required skill to apply the statistical tools in engineering problems.
- To introduce the basic concepts of probability and random variables.
- To introduce the basic concepts of two dimensional random variables.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of classifications of design of experiments which plays very important roles in the field of agriculture and statistical quality control.

UNIT I PROBABILITY AND RANDOM VARIABLES

9 + 3

Axioms of probability – Conditional probability – Baye’s theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions – Functions of a random variable.

UNIT II TWO- DIMENSIONAL RANDOM VARIABLES 9 + 3

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III ESTIMATION THEORY 9 + 3

Unbiased estimators - Efficiency - Consistency - Sufficiency - Robustness - Method of moments - Method of maximum Likelihood - Interval estimation of Means - Differences between means, variations and ratio of two variances

UNIT IV NON- PARAMETRIC TESTS 9 + 3

Introduction - The Sign test - The Signed - Rank test - Rank - sum tests - The U test - The H test - Tests based on Runs - Test of randomness - The Kolmogorov Tests .

UNIT V STATISTICAL QUALITY CONTROL 9 + 3

Control charts for measurements (\bar{X} and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1:Understand the fundamental knowledge of the concepts of probability and have knowledge of standard distributions which can describe real life phenomenon.

CO2:Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.

CO3:Apply the concept of testing of hypothesis for small and large samples in real life problems.

CO4:Apply the basic concepts of classifications of design of experiments in the field of agriculture and statistical quality control.

CO5:Have the notion of sampling distributions and statistical techniques used in engineering and management problems.

TEXT BOOKS

1. Johnson. R.A., Miller. I.R and Freund . J.E, " Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 9th Edition, 2016.
2. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4th Edition, 2007.
3. John E. Freund, "Mathematical Statistics", Prentice Hall, 5th Edition, 1992.

REFERENCES:

1. Gupta. S.C. and Kapoor. V. K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi, 12th Edition, 2020.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014.
3. Ross. S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 5th Edition, Elsevier, 2014.

value Stores – Column Based Systems – Graph Databases. Database Security: Security issues – Access control based on privileges – Role Based access control – SQL Injection – Statistical Database security – Flow control – Encryption and Public Key infrastructures – Challenges

COURSE OUTCOMES:

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

- CO1:**Construct SQL Queries using relational algebra
- CO2:**Design database using ER model and normalize the database
- CO3:** Construct queries to handle transaction processing and maintain consistency of the database
- CO4:** Compare and contrast various indexing strategies and apply the knowledge to tune the performance of the database
- CO5:** Appraise how advanced databases differ from Relational Databases and find a suitable database for the given requirement.

TOTAL:45 PERIODS

TEXT BOOKS

1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, “Database System Concepts”, Seventh Edition, McGraw Hill, 2020.
2. Ramez Elmasri, Shamkant B. Navathe, “Fundamentals of Database Systems”, Seventh Edition, Pearson Education, 2017

REFERENCES:

1. C.J.Date, A.Kannan, S.Swamynathan, “An Introduction to Database Systems”, Eighth Edition, Pearson Education, 2006.

AL3452

OPERATING SYSTEMS

L T P C
3 0 2 4

COURSE OBJECTIVES:

- To understand the basics and functions of operating systems.
- To understand Processes and Threads
- To analyze Scheduling algorithms and process synchronization.
- To understand the concept of Deadlocks.
- To analyze various memory management schemes.
- To be familiar with I/O management and File systems.
- To be familiar with the basics of virtual machines and Mobile OS like iOS and Android.

UNIT I INTRODUCTION

7

Computer System - Elements and organization; Operating System Overview - Objectives and Functions - Evolution of Operating System; Operating System Structures – Operating System Services - User Operating System Interface - System Calls – System Programs - Design and Implementation - Structuring methods.

UNIT-II PROCESS MANAGEMENT

11

Processes - Process Concept - Process Scheduling - Operations on Processes - Inter-process Communication; CPU Scheduling - Scheduling criteria - Scheduling algorithms: Threads - Multithread Models – Threading issues; Process Synchronization - The critical-section problem -

Synchronization hardware – Semaphores – Mutex - Classical problems of synchronization - Monitors; Deadlock - Methods for handling deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection, Recovery from deadlock.

UNIT III MEMORY MANAGEMENT

10

Main Memory - Swapping - Contiguous Memory Allocation – Paging - Structure of the Page Table - Segmentation, Segmentation with paging; Virtual Memory - Demand Paging – Copy on Write - Page Replacement - Allocation of Frames –Thrashing.

UNIT IV STORAGE MANAGEMENT

10

Mass Storage system – Disk Structure - Disk Scheduling and Management; File-System Interface - File concept - Access methods - Directory Structure - Directory organization - File system mounting - File Sharing and Protection; File System Implementation - File System Structure - Directory implementation - Allocation Methods - Free Space Management; I/O Systems – I/O Hardware, Application I/O interface, Kernel I/O subsystem.

UNIT V VIRTUAL MACHINES AND MOBILE OS

7

Virtual Machines – History, Benefits and Features, Building Blocks, Types of Virtual Machines and their Implementations, Virtualization and Operating-System Components; Mobile OS - iOS and Android.

PRACTICAL EXERCISES:

45 PERIODS

30 PERIODS

1. Installation of Operating system : Windows/ Linux
2. Illustrate UNIX commands and Shell Programming
3. Process Management using System Calls : Fork, Exec, Getpid, Exit, Wait, Close
4. Write C programs to implement the various CPU Scheduling Algorithms
5. Illustrate the inter process communication strategy
6. Implement mutual exclusion by Semaphores
7. Write a C program to avoid Deadlock using Banker's Algorithm
8. Write a C program to Implement Deadlock Detection Algorithm
9. Write C program to implement Threading
10. Implement the paging Technique using C program
11. Write C programs to implement the following Memory Allocation Methods
 - a. First Fit
 - b. Worst Fit
 - c. Best Fit
12. Write C programs to implement the various Page Replacement Algorithms
13. Write C programs to Implement the various File Organization Techniques
14. Implement the following File Allocation Strategies using C programs
 - a. Sequential
 - b. Indexed
 - c. Linked
15. Write C programs for the implementation of various disk scheduling algorithms

COURSE OUTCOMES:

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

CO1: Analyze various scheduling algorithms and process synchronization.

CO2 : Explain deadlock, prevention and avoidance algorithms.

- CO3 : Compare and contrast various memory management schemes.
 CO4 : Explain the functionality of file systems I/O systems, and Virtualization
 CO5 : Compare iOS and Android Operating Systems.

TOTAL:75 PERIODS

TEXTBOOKS

1. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, "Operating System Concepts", 9th Edition, John Wiley and Sons Inc., 2018.
2. Andrew S Tanenbaum, "Modern Operating Systems", Pearson, 4th Edition, New Delhi, 2016.

REFERENCES

1. Ramaz Elmasri, A. Gil Carrick, David Levine, "Operating Systems – A Spiral Approach", Tata McGraw Hill Edition, 2010.
2. William Stallings, "Operating Systems: Internals and Design Principles", 7th Edition, Prentice Hall, 2018.
3. Achyut S.Godbole, Atul Kahate, "Operating Systems", McGraw Hill Education, 2016.

CW3401

INTRODUCTION TO BUSINESS SYSTEMS

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To develop and strengthen business quality and motivation in students
- To impart basic business skills
- To understanding to run a business efficiently and effectively.

UNIT I OVERVIEW OF BUSINESS SYSTEM 9

Business environmental factors - Internal and External. System approach of management Process - Input for the business, Transformational process and output. Objectives of the business system. System model of business management. Management functions – Planning, Organising, Staffing, Directing and Controlling.

UNIT II OUTLINE OF BUSINESS ORGANIZATION 9

Types of Business organization - Sole proprietorship, partnership, company-public and private sector enterprises, Multinational and Global companies. Managing Global environment. Management levels and types.

UNIT III FUNCTIONS OF BUSINESS 9

Functions and Objectives – Production, Marketing, Finance, Human Resource, quality control and Research & development.

UNIT IV MEASURING BUSINESS PERFORMANCE AND CONTROL PROCESS 9

Key performance indicators. Financial statement analysis- Cash flow analysis, ROI, working capital, cost volume profit analysis. Customer - satisfaction Retention and acquisition. Employee

Probabilistic discriminative model - Logistic regression, Probabilistic generative model – Naive Bayes, Maximum margin classifier – Support vector machine, Decision Tree, Random Forests

UNIT III ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING 9

Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging, boosting, stacking, Unsupervised learning: K-means, Instance Based Learning: KNN, Gaussian mixture models and Expectation maximization.

UNIT IV NEURAL NETWORKS 9

Multilayer perceptron, activation functions, network training – gradient descent optimization – stochastic gradient descent, error backpropagation, from shallow networks to deep networks –Unit saturation (aka the vanishing gradient problem) – ReLU, hyperparameter tuning, batch normalization, regularization, dropout.

UNIT V DESIGN AND ANALYSIS OF MACHINE LEARNING EXPERIMENTS 8

Guidelines for machine learning experiments, Cross Validation (CV) and resampling – K-fold CV, bootstrapping, measuring classifier performance, assessing a single classification algorithm and comparing two classification algorithms – *t* test, McNemar's test, K-fold CV paired *t* test

COURSE OUTCOMES:

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

CO1: Explain the basic concepts of machine learning.

CO2 : Construct supervised learning models.

CO3 : Construct unsupervised learning algorithms.

CO4: Evaluate and compare different models

TOTAL:45 PERIODS

TEXTBOOKS:

1. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Fourth Edition, 2020.
2. Stephen Marsland, "Machine Learning: An Algorithmic Perspective, "Second Edition", CRC Press, 2014.

REFERENCES

1. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
2. Tom Mitchell, "Machine Learning", McGraw Hill, 3rd Edition, 1997.
3. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, "Foundations of Machine Learning", Second Edition, MIT Press, 2012, 2018.
4. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016
5. Sebastain Raschka, Vahid Mirjalili , "Python Machine Learning", Packt publishing 3rd Edition, 2019.

GE3451

ENVIRONMENTAL SCIENCES AND SUSTAINABILITY

L T P C

2 0 0 2

UNIT I ENVIRONMENT AND BIODIVERSITY 6

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem

diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.

UNIT II ENVIRONMENTAL POLLUTION 9

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts .

UNIT III RENEWABLE SOURCES OF ENERGY 6

Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

UNIT IV SUSTAINABILITY AND MANAGEMENT 6

Development , GDP ,Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols-Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.

UNIT V SUSTAINABILITY PRACTICES 6

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources, Energy Cycles-carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio-economical and technological change.

TOTAL: 30 PERIODS

TEXT BOOKS:

1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers ,2018.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.

REFERENCES :

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38 . edition 2010.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, Third Edition, 2015.
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

CS3481

DATABASE MANAGEMENT SYSTEMS LABORATORY

L T P C
0 03 1.5

COURSE OBJECTIVES:

- To learn and implement important commands in SQL.
- To learn the usage of nested and joint queries.
- To understand functions, procedures and procedural extensions of databases.
- To understand design and implementation of typical database applications.
- To be familiar with the use of a front end tool for GUI based application development.

LIST OF EXPERIMENTS:

1. Create a database table, add constraints (primary key, unique, check, Not null), insert rows, update and delete rows using SQL DDL and DML commands.
2. Create a set of tables, add foreign key constraints and incorporate referential integrity.
3. Query the database tables using different 'where' clause conditions and also implement aggregate functions.
4. Query the database tables and explore sub queries and simple join operations.
5. Query the database tables and explore natural, equi and outer joins.
6. Write user defined functions and stored procedures in SQL.
7. Execute complex transactions and realize DCL and TCL commands.
8. Write SQL Triggers for insert, delete, and update operations in a database table.
9. Create View and index for database tables with a large number of records.
10. Create an XML database and validate it using XML schema.
11. Create Document, column and graph based data using NOSQL database tools.
12. Develop a simple GUI based database application and incorporate all the above-mentioned features
13. Case Study using any of the real life database applications from the following list
 - a) Inventory Management for a EMart Grocery Shop
 - b) Society Financial Management
 - c) Cop Friendly App – Eseva
 - d) Property Management – eMall
 - e) Star Small and Medium Banking and Finance

- Build Entity Model diagram. The diagram should align with the business and functional goals stated in the application.
 - Apply Normalization rules in designing the tables in scope.
 - Prepared applicable views, triggers (for auditing purposes), functions for enabling enterprise grade features.
 - Build PL SQL / Stored Procedures for Complex Functionalities, ex EOD Batch Processing for calculating the EMI for Gold Loan for each eligible Customer.
- Ability to showcase ACID Properties with sample queries with appropriate settings

List of Equipments:(30 Students per Batch)

MYSQL / SQL : 30 Users

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Create databases with different types of key constraints.

CO2: Construct simple and complex SQL queries using DML and DCL commands.

CO3: Use advanced features such as stored procedures and triggers and incorporate in GUI based application development.

CO4: Create an XML database and validate with meta-data (XML schema).

CO5: Create and manipulate data using NOSQL database.

AL3461

MACHINE LEARNING LABORATORY

L T P C

0 0 4 2

COURSE OBJECTIVES:

- To understand the data sets and apply suitable algorithms for selecting the appropriate features for analysis.
- To learn to implement supervised machine learning algorithms on standard datasets and evaluate the performance.
- To experiment the unsupervised machine learning algorithms on standard datasets and evaluate the performance.
- To build the graph based learning models for standard data sets.
- To compare the performance of different ML algorithms and select the suitable one based on the application.

LIST OF EXPERIMENTS:

1. For a given set of training data examples stored in a .CSV file, implement and demonstrate the **Candidate-Elimination algorithm** to output a description of the set of all hypotheses consistent with the training examples.
2. Write a program to demonstrate the working of the decision tree based **ID3 algorithm**. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
3. Build an Artificial Neural Network by implementing the **Backpropagation algorithm** and test the same using appropriate data sets.
4. Write a program to implement the **naïve Bayesian classifier** for a sample training data set stored as a .CSV file and compute the accuracy with a few test data sets.

5. Implement **naïve Bayesian Classifier** model to classify a set of documents and measure the accuracy, precision, and recall.
6. Write a program to construct a **Bayesian network** to diagnose CORONA infection using standard WHO Data Set.
7. Apply **EM algorithm** to cluster a set of data stored in a .CSV file. Use the same data set for clustering using the k-Means **algorithm**. Compare the results of these two algorithms.
8. Write a program to implement **k-Nearest Neighbour algorithm** to classify the iris data set. Print both correct and wrong predictions.
9. Implement the non-parametric **Locally Weighted Regression algorithm** in order to fit data points. Select an appropriate data set for your experiment and draw graphs.

List of Equipments:(30 Students per Batch)

The programs can be implemented in either Python or R.

TOTAL:60 PERIODS

COURSE OUTCOMES:

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

1. Apply suitable algorithms for selecting the appropriate features for analysis.
2. Implement supervised machine learning algorithms on standard datasets and evaluate the performance.
3. Apply unsupervised machine learning algorithms on standard datasets and evaluate the performance.
4. Build the graph based learning models for standard data sets.
5. Assess and compare the performance of different ML algorithms and select the suitable one based on the application.

CW3411

BUSINESS COMMUNICATION LABORATORY II

L T P C

0 0 3 1.5

COURSE OBJECTIVES:

- To augment students overall communication and thus aid in helping them
- To improve their interpersonal skills by engaging them in group activities
- To emerge as professionals.

LIST OF EXPERIMENTS:

- 1: Writing letters and creating mails
- 2: Construction of paragraphs and essays
3. Speaking skills and methods of speech
4. Leadership, Communication and Interpersonal skills
5. Being a motivator and role model
6. Corporate Etiquettes
7. Professionalism in the workplace
8. Engineering ethics, rights and responsibilities
9. Managing cultural diversities and global diversities

10. Right use of social media
11. Maintaining the image and pride of the organization
12. Winning formula for a successful manager/leader

List of Equipments:(30 Students per Batch)

1: Systems with Rosetta stone and Globarena

COURSE OUTCOMES:

CO1: Speak fluently in English without errors in the sentence construction and hence present themselves as effective English communicators.

CO2: Differentiate between vocabularies used as adjectives, verbs.

CO3: Deliver a public speech according to the need of the audience and also be aware of positive body language to be manifested during a speech.

CO4: Deal with the deeper parameters of working in teams like team motivation, multicultural team activity and team conflict resolution.

CO5: Set realistic goals in terms of personal and professional growth.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Bovee, Thill and Raina, "Business Communication Today", Pearson Education, 2017.
2. APAART: Speak Well 1 (English Language and Communication)
3. APAART: Speak Well 2 (Soft Skills)

REFERENCES:

1. Charles Marsh , "Strategic Communication", New International Edition, 2013.
2. Alan Mc'carthy and O'dell, " English Vocabulary in Use, Cambridge University Press, 4th edition, 2017.
3. Dr. Saroj Hiremath , "Business Communication", Nirali Prakashan, 2018.