**NOIDA INTERNATIONAL UNIVERSITY**



**School of Engineering & Technology**

**SCHEME OF EVALUATION & SYLLABUS**

**for**

**BACHELOR OF TECHNOLOGY in Mechatronics Engineering [B. Tech. (Mechatronics)]**

**w.e.f. Academic Session 2022-2023onwards**

**Program Curriculum**

**FOR B. Tech. (Mechatronics)**

**(Effective from Academic Session 2021-2022)**

***B. Tech. in Mechatronics is undoubtedly one of the most sought-after specializations of Engineering. B. Tech. Mechatronics is a Four-Year Undergraduate program with strong focus on students’ learning in the modern fields of mechatronics which are the harbinger of Digital Transformation worldwide. Mechatronics refers to the deployment of machines to enable them to perform tasks with intelligence like humans. The goal of mechatronics generally is to design intelligent machines that can assist people in their everyday life. It is an interdisciplinary branch that includes electronics, mechanical, information, and computer science engineering. It deals with the design and development of robots. The mechatronics graduates can find jobs in private manufacturing & design companies, public organizations, military & defence, education, agriculture, healthcare, etc. Some of the jobs available in the field of mechatronics are Robotics Engineer, Robotics Designer & Analyst, Robotics Sales Engineer, Research Scientist, Automation engineer etc. The mechatronics graduates will be demanded in sectors like mining industry, telecommunications, forest industry, food industry, industrial engineering, space exploration, healthcare, transportation, etc. So, they can find jobs in any of the above-mentioned sectors.***

**Program Educational Objectives (POs)**

The Department of Mechatronics has developed and maintained a well-defined set of Program Educational Objectives and desired Program Outcomes. Educational objectives of the program cater to the requirements of the stakeholders such as students, parents, employers, alumni, faculty etc. The Program Educational Objectives are as follows:

After few years of Graduation, the Graduates of **B. Tech. (Mechatronics)** will be able to:

|  |  |
| --- | --- |
| * **PEO1:** | Achieve professional growth in an engineering position in regional and national industries. Growth can be evidenced by promotions and appointment in the workplace (management positions, technical specialization), entrepreneurial activities, and consulting activities. |
| * **PEO2:** | Success in advanced engineering studies evidenced by enrolment in graduate courses, completion of graduate degree programs, presentations and publications at professional events, and awards or licenses associated with advanced studies. |
| * **PEO3:** | Realization of impactful achievements in societal roles demonstrated by attainment of community leadership roles, mentoring activities, civic outreach service, and active roles in professional societies. |

**Program Outcomes (POs)**

***On successful completion of B. Tech. (Mechatronics) Engineering Graduates will be able to:***

* **PO**1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
* **PO**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.
* **PO**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.
* **PO**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.
* **PO**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.
* **PO**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.
* **PO**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.
* **PO**8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
* **PO**9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
* **PO**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.
* **PO**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.
* **PO**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.

**Program Specific Outcomes (PSOs)**

On successful completion of the program, the graduates of B. Tech (Mechatronics) program will be able to:

* **PSO1:** Provide the solutions to problems faced in the industrial area related to the field of Mechatronics Engineering.
* **PSO2:** Design and develop new application with help of Mechatronics using modern tools.

**Credit System:** Credit requirement for award of B. Tech (Mechatronics):

* Every semester shall offer a minimum of **21 credits** and a maximum of **29 credits**.
* Total Credits for the Project or Thesis in the program can vary from **12 to 18**.
* The total number of credits for the B. Tech Degree program could vary from a **minimum of 145** credits to a **maximum of 163** credits.
* All courses of study put together in the program would engage the students for a **minimum of 28 periods** or hours of study a week and a **maximum of 37 periods** or hours a week.

Under the CHOICE BASED CREDIT SYSTEM (CBCS), which is a student or learner centric system, the courses of study in the B. Tech Degree program shall be as under:

1. Basic Sciences and Engineering Science (BS and ES) Course: A course which informs the Professional core and should compulsorily be studied.
2. Professional Core (PC) Course: A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.
3. Elective Course: Generally, a course which can be chosen from a pool of courses and are of two types:
   1. Professional Elective (PE) which may be very specific or specialized or advanced or supportive to the discipline or subject of study or which provides an extended scope
   2. Open Elective (OE) which enables an exposure to some other discipline or subject or domain or nurtures the candidates’ proficiency or skill

The Weightage in terms of Credits for each of the above in the prescribed curriculum of the School is as follows:

|  |  |  |
| --- | --- | --- |
| **S.**  **No.** | **Credit Breakups** | **Credits** |
| 1 | Humanities and Social Sciences including Management Courses | 12 |
| 2 | Basic Science Courses | 21 |
| 3 | Mechatronics Engineering Core Courses | 101 |
| 4 | Professional Elective Core Courses | 6 |
| 5 | Open Elective Courses relevant to chosen Specialization/Branch | 6 |
| 6 | Project Work, Seminar, and Internship in Industry or elsewhere | 17 |
| 7 | Audit Course | Non-Credit |
|  | **Total Credits** | 163 |

While calculating credits the following guidelines is adopted, namely: -

* 1 Hr. Lecture (L) per week 1 credit
* 1 Hr. Tutorial (T) per week 1 credit
* 1 Hr. Practical (P) per week 0.5
* 2 Hours Practical (Lab)/week 1 credit**Credit distribution in each semester** (199 credits to 8 semesters)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Semester** | **Hrs. (Credits)** | | | |
| **Lecture** | **Tutorials** | **Practical** | **Total** |
| **1st** | 17 **(15)** | 2 **(2)** | 14 **(7)** | 33 **(24)** |
| **2nd** | 18 **(16)** | 2 **(2)** | 12 **(6)** | 32 **(24)** |
| **3rd** | 17 **(17)** | 5 **(5)** | 6 **(3)** | 28 **(25)** |
| **4th** | 17 **(17)** | 5 **(5)** | 6 **(3)** | 28 **(25)** |
| **5th** | 21 **(21)** | 4 **(4)** | 6 **(3)** | 31 **(28)** |
| **6th** | 23 **(21)** | 1 **(1)** | 8 **(4)** | 32 **(27)** |
| **7th** | 18 **(18)** | 0 **(0)** | 14 **(7)** | 32 **(25)** |
| **8th** | 11 **(11)** | 0 **(0)** | 18 **(9)** | 35 **(20)** |
| **Total Credits** | 142 **(136)** | 19 **(19)** | **84 (42)** | 245 **(198)** |

**Course Coding System**: Every Course coded as follows:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Type of Course** | **First 2 Alphabets** | **Next 2 Alphabets** | **X1** | **X2** | **X3** | **X4** | **Second Last Alphabet** | **(Last Alphabet)** | **Example** |
| Basic Science Courses (BSC) | BT | SC | Version | Semester | Course Number | | T: Theory  P: Practical  E: Professional Elective  O: Open Elective  S: Seminar/Industrial Training/Project/Thesis | Thread Identifier for Professional Elective  (Only where Professional Elective Threads are implemented.) | BTSC1101T |
| Engineering Science Course (ESC) | BT | ES | Version | Semester | Course Number | | BTES1101T |
| Humanities and Social Sciences including Management (HSMC) | BT | HM | Version | Semester | Course Number | | BTHM1101T |
| Program Core Courses (PCC) | BT | CS | Version | Semester | Course Number | | BTME1301T |
| Program Elective Courses (PEC) | BT | CS | Version | Semester | Course Number | | BTME1501E(A) |
| Open Elective Courses (OEC) | BT | CS | Version | Semester | Course Number | | BTME1701O |
| Mandatory Courses (MC) | BT | MC | Version | Semester | Course Number | | BTMC1101T |
| Any Course Common to Other Department | BT | <##> | Version | Semester | Course Number | | BTEC1403T |

**## Parent Department where this Course belongs to:**

AE: Automobile Engineering

BT: Bio Technology

CE: Civil Engineering

CS: Computer Science & Engineering

EC: Electronics & Communication Engineering

EE: Electrical Engineering

EN: Electrical & Electronics Engineering

IT: Information Technology

MR: Mechatronics Engineering

**Bachelor of Technology (Mechatronics)**

**Fifth Semester**

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| **S.**  **No.** | **University**  **Course Code** | **Course Name** | **Period Schedule** | | | **Evaluation Scheme** | | | | | | | | |
| **Internal Assessment** | | | | | **External**  **Assessment** | **Total** | **Total Credits** |
| **L** | **T** | **P** | **CT** | **TA** | | **AT** | **Total** |
| 1 | BTMR1501T | Digital Signal Processing | 2 | 1 | 0 | 20 | 10 | 10 | | 40 | 60 | 100 | 3 |
| 2 | BTMR1502T | Sensor & Instrumentation | 2 | 1 | 0 | 20 | 10 | 10 | | 40 | 60 | 100 | 3 |
| 3 | BTMR1503T | Control System Engineering | 3 | 0 | 0 | 20 | 10 | 10 | | 40 | 60 | 100 | 3 |
| 4 | BTMR1504T | Industrial Management | 3 | 0 | 0 | 20 | 10 | 10 | | 40 | 60 | 100 | 2 |
| 5 | BTMR1505T | Kinematics & Theory of Machines | 2 | 1 | 0 | 20 | 10 | 10 | | 40 | 60 | 100 | 3 |
| 6 | BTMR1506T | Entrepreneurship and Startups | 3 | 0 | 0 | 20 | 10 | 10 | | 40 | 60 | 100 | 3 |
| 7 | BTHM1501T | Indian Constitution | 2 | 0 | 0 | 20 | 10 | 10 | | 40 | 60 | 100 | 0 |
| **PRACTICALS** | | | | | | | | | | | | | |
| 1 | BTMR1501P | Digital Signal Processing Lab | 0 | 0 | 2 | 20 | 10 | 10 | | 40 | 60 | 100 | 1 |
| 2 | BTMR1502P | Sensor & Instrumentation Lab | 0 | 0 | 2 | 20 | 10 | 10 | | 40 | 60 | 100 | 1 |
| 3 | BTMR1503P | Control System Engineering Lab | 0 | 0 | 2 | 20 | 10 | 10 | | 40 | 60 | 100 | 1 |
| 4 | BTMR1504P | Mini Project or Internship | 0 | 0 | 2 | 20 | 10 | 10 | | 40 | 60 | 100 | 1 |
| **TOTAL** | | | 17 | 3 | 8 | 220 | 110 | 110 | | 440 | 660 | 1100 | 21 |

**Mini Project or Internship shall be conducted during summer break after semester IV and assessed during semester V**

**Bachelor of Technology (Mechatronics)**

**Sixth Semester**

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| **S.**  **No.** | **University**  **Course Code** | **Course Name** | **Period Schedule** | | | **Evaluation Scheme** | | | | | | | |
| **Internal Assessment** | | | | **External**  **Assessment** | **Total** | **Total Credits** |
| **L** | **T** | **P** | **CT** | **TA** | **AT** | **Total** |
| 1 | BTMR1601T | Design of Machine Element | 3 | 0 | 0 | 20 | 10 | 10 | 40 | 60 | 100 | 3 |
| 2 | BTMR1602T | Computer Network and Cyber Security | 3 | 1 | 0 | 20 | 10 | 10 | 40 | 60 | 100 | 3 |
| 3 | BTMR1603T | Microprocessor and Microcontroller | 3 | 0 | 0 | 20 | 10 | 10 | 40 | 60 | 100 | 3 |
| 4 | BTMR1604T | Manufacturing Technology | 3 | 0 | 0 | 20 | 10 | 10 | 40 | 60 | 100 | 3 |
| 5 |  | Professional Elective Course I | 3 | 0 | 0 | 20 | 10 | 10 | 40 | 60 | 100 | 3 |
| **Practical** | | | | | | | | | | | | |
| 1 | BTMR1601P | Computer Aided Design Lab | 0 | 0 | 2 | 20 | 10 | 10 | 40 | 60 | 100 | 2 |
| 2 | BTMR1602P | Computer Network and Cyber security Lab | 0 | 0 | 2 | 20 | 10 | 10 | 40 | 60 | 100 | 1 |
| 3 | BTMR1603P | Microprocessor and Microcontroller Lab | 0 | 0 | 2 | 20 | 10 | 10 | 40 | 60 | 100 | 2 |
| 4 | BTMR1604S | Manufacturing Technology Lab | 0 | 0 | 2 | 20 | 10 | 10 | 40 | 60 | 100 | 1 |
| 5 | BTMR1605S | Seminar | 0 | 0 | 2 | 20 | 10 | 10 | 40 | 60 | 100 | 1 |
| **Total** | | | 15 | 1 | 10 | 100 | 100 | 100 | 400 | 600 | 1000 | 22 |

**Mini Project or Internship shall be conducted during summer break after semester VI and will be assessed during Semester VII**

**Detailed 5th Semester Curriculum Contents**

**Undergraduate Degree in Engineering and Technology**

**BRANCH COURSE: MECHATRONICS ENGINEERING**

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| Course Code | : | BTMR1501T |
| Course Title | : | Digital Signal Processing |
| Number of Credits | : | 3 (L: 2; T: 1; P: 0) |
| Course Category | : | MT |

##### Course Objective:

1. To learn the basic concepts and properties of discrete time signals and system.
2. To learn the frequency domain characteristics of discrete time signals and systems.
3. To design and implement digital filter design techniques.

##### Course Contents:

**Module I: Discrete-time signals and systems**

Discrete time signals and systems: Sequences; representation of signals on orthogonal basis; Representation of discrete systems using difference equations, Sampling and reconstruction of signals - aliasing; Sampling theorem and Nyquist rate.

**Module II: Z-transform**

z-Transform, Region of Convergence, Analysis of Linear Shift Invariant systems using z- transform, Properties of z-transform for causal signals, Interpretation of stability in z- domain, Inverse z-transforms.

**Module III: Discrete Fourier Transform**

Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Convolution of signals, Fast Fourier Transform Algorithm, Parseval’s Identity, Implementation of Discrete Time Systems.

##### Module IV: Design of Digital filters

Design of FIR Digital filters: Window method, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Low-pass, Band- pass, Band- stop and High-pass filters.

Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to multi-rate signal processing.

**Module V: Applications of Digital Signal Processing**

Correlation Functions and Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter.

##### Text Books/References:

1. S.K. Mitra, Digital Signal Processing: A computer based approach.TMH
2. A.V. Oppenheim and Schafer, Discrete Time Signal Processing, Prentice Hall, 1989.
3. John G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Prentice Hall, 1997.
4. L.R. Rabiner and B. Gold, Theory and Application of Digital Signal Processing, Prentice Hall, 1992.
5. J.R. Johnson, Introduction to Digital Signal Processing, Prentice Hall, 1992.
6. D.J. DeFatta, J. G. Lucas and W.S.Hodgkiss, Digital Signal Processing, John Wiley& Sons, 1988.

##### Alternative NPTEL/SWAYAM Course:

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| --- | --- | --- | --- |
| **S. No.** | **NPTEL Course Name** | **Instructor** | **Host Institute** |
| 1. | Digital Signal Processing | C.S Ramalingam | IIT Madras |
| 2. | Digital Signal Processing | Prof. S.C Dutta | IIT Delhi |

**Course Outcomes:** At the end of the course student will be able:

1. To Represent signals mathematically in continuous and discrete-time, and in the frequency domain.
2. To Analyze discrete-time systems using z-transform.
3. To Understand the Discrete-Fourier Transform (DFT) and the FFT algorithms.
4. To Design digital filters for various applications.
5. To Apply digital signal processing for the analysis of real-life signals.

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| Course Code | : | BTMR1502T |
| Course Title | : | Sensors & Instrumentation |
| Number of Credits | : | 3 (L: 2; T: 1; P: 0) |
| Course Category | : | MT |

**Course Objective:** The course provides good knowledge of working of different types of sensors used in various application areas. The course also provides knowledge of interfacing of electronic circuits with different sensors for its applications in different fields.

##### Course Contents:

**Module I: Sensors Fundamentals and Characteristics:** Sensors, Signals and Systems; Sensor Classification; Modules of Measurements; Sensor Characteristics.

**Module II: Physical Principles of Sensing:** Electric Charges, Fields, and Potentials; Capacitance; Magnetism; Induction; Resistance; Piezoelectric Effect; Hall Effect; Temperature and Thermal Properties of Material; Heat Transfer; Light; Dynamic Models of Sensor Elements.

**Module III: Interface Electronic Circuits:** Input Characteristics of Interface Circuits, Amplifiers, Excitation Circuits, Analog to Digital Converters, Direct Digitization and Processing, Bridge Circuits, Data Transmission, Batteries for Low Power Sensors.

**Module IV: Sensors in Different Application**: Area Occupancy and Motion Detectors; Position, Displacement, and Level; Velocity and Acceleration; Force, Strain, and Tactile Sensors; Pressure Sensors, Temperature Sensors.

**Module V: Sensor Materials and Technologies**: Materials, Surface Processing, Nano- Technology.

##### Text Books/References:

1. J. Fraden, Handbook of Modern Sensors: Physical, Designs, and Applications, AIP Press, Springer.
2. D. Patranabis, Sensors and Transducers, PHI Publication, New Delhi
3. Mechatronics- Ganesh S. Hegde, Published by University Science Press (An imprint of Laxmi Publication Private Limited).

##### Course Outcomes:

1. To Understand the concept of sensors and its characteristics.
2. To Understand the practical approach in design of technology based on different sensors
3. To Learn various sensor materials and technology used in designing sensors.
4. To demonstrate different sensors work
5. To Develop a sense for recognizing bad data and an intuition of how to resolve problems.

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| Course Code | : | BTMR1503T |
| Course Title | : | Control System Engineering |
| Number of Credits | : | 3 (L: 3; T: 0; P: 0) |
| Course Category | : | MT |

##### Course Objective:

* To teach the fundamental concepts of control systems & mathematical modelling of system.
* To study the concept of time response and frequency response of the system.
* To teach the basics of stability analysis of 6the system.

##### Course Contents:

**Module-I:** Introduction to control problem- Industrial Control examples. Transfer function. System with dead-time. System response. Control hardware and their models: potentiometers, synchro’s, LVDT, dc and ac servomotors, tacho-generators, electro hydraulic valves, hydraulic servomotors, electro pneumatic valves, pneumatic actuators. Closed-loop systems. Block diagram and signal flow graph analysis.

**Module-II:** Feedback control systems- Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness. proportional, integral and derivative systems. Feed- forward and multi-loop control configurations, stability concept, relative stability, Routh stability criterion.

**Module-III:** Time response of second-order systems, steady-state errors and error constants. Performance specifications in time-domain. Root locus method of design. Lead and lag compensation.

**Module-IV:** Frequency-response analysis- Polar plots, Bode plot, stability in frequency domain, Nyquist plots. Nyquist stability criterion. Performance specifications in frequency-domain. Frequency- domain methods of design, Compensation & their realization in time & frequency domain. Lead and Lag compensation. Op-amp based and digital implementation of compensators. Tuning of process controllers. State variable formulation and solution.

**Module-V:** State variable Analysis- Concepts of state, state variable, state model, state models for linear continuous time functions, diagonalization of transfer function, solution of state equations, concept of controllability & observability.

Introduction to Optimal control & Nonlinear control, Optimal Control problem, Regulator problem, Output regulator, trekking problem. Nonlinear system – Basic concept & analysis.

##### Text Books/References:

1. Gopal. M., “Control Systems: Principles and Design”, Tata McGraw-Hill, 1997.
2. Kuo, B.C., “Automatic Control System”, Prentice Hall, sixth edition, 1993.
3. Ogata, K., “Modern Control Engineering”, Prentice Hall, second edition, 1991.
4. Nagrath & Gopal, “Modern Control Engineering”, New Age International, New Delhi.
5. Ambikapathy A., Control System, Khanna Book Publishing Company, 2018.

##### Alternative NPTEL/SWAYAM Course:

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| --- | --- | --- | --- |
| **S. No.** | **NPTEL Course Name** | **Instructor** | **Host Institute** |
| 1. | Control Systems | Prof. C.S Shankar Ram | IIT Madras |

**Course Outcomes:** At the end of this course, students will demonstrate the ability:

1. To Understand the modelling of linear invariant systems using transfer function and state space representations.
2. To Understand the concept of stability and its assessment for linear time invariant systems.
3. To Design simple feedback controllers.

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| --- | --- | --- |
| Course Code | : | BTMR1504T |
| Course Title | : | Industrial Management |
| Number of Credits | : | 2 (L: 2; T: 0; P: 0) |
| Course Category | : | MT |

**Course Objective:** The aim of the course is to understand the basic principles of management, and the four major functions of managers e.g. planning, organizing, leading and controlling and how managers actually operate. Students will be required to think critically and strategically about management theories and issues which will enable them to develop their decision-making and analytical skills. They will be involved in application exercises and case studies which will assist them to develop graduate attributes.

##### Course Contents:

**Module-I:** Introduction: Concept and scope of Industrial Management. Productivity: Definition, measurement, productivity index, types of production system, Industrial Ownership.

Functions of Management, Taylor’s Scientific Management Theory, Fayol’s Principles of Management, Social responsibilities of Management,

**Module-II:** Introduction to Human resources management: Nature of HRM, functions and importance of HRM.

**Work Study:** Introduction, definition, objectives, steps in work study, Method study: definition, objectives, steps of method study, Work Measurement: purpose, types of study stop watch methods steps allowances standard time calculations work sampling,

**Module-III:** Production Planning and Control Inventory Control: Inventory, Cost, Models of inventory control: EOQ, ABC, VED. Quality Control: statistical quality control, Control charts for variables and attributes, Acceptance Sampling- Single sampling- Double sampling plans, Introduction to TQM.

**Module-IV:** Project Planning & Scheduling Introduction to PERT & CPM, planning and scheduling networks, time estimation, determination of critical path, CPM model, event slacks & floats, PERT model, expected time for activities, expected length of critical path, calculating the project length and variance, PERT & CPM cost accounting systems, lowest cost schedule, crashing of networks, linear programming formulation of event oriented networks, updating of networks, LOB technique.

**Module-V:** Modification & Extensions of Network Models Complexity of project scheduling with limited resources, resource leveling of project schedules, resource allocation in project scheduling - heuristic solution. Precedence networking- examples with algorithm, decision networks, probabilistic networks, computer aided project management essential requirements of PM software, software packages for CPM. Enterprise- wide PM, using spread sheets for financial projections.

##### Text Books/References:

1. Engineering Management (Industrial Engineering & Management), S.C. Sharma & T.R. Banga, Khanna Book Publishing Co. (P) Ltd., Delhi (ISBN: 978-93-86173-072)
2. Industrial Engineering and Management, P. Khanna, Dhanpat Rai publications Ltd.
3. Production & Operation Management, Paneer Selvam, PHI.
4. Industrial Engineering Management, NVS Raju, Cengage Learning.
5. Industrial Engineering Management, Ravi Shankar, Galgotia.

##### Course Outcomes:

Student is able:

1. To apply principles of management in his / her extra and co-curricular activity in college and in industrial in-plant training.
2. To apply work improvement techniques in an organization where he undergoes for in-plant training.
3. To compare & find out and reduce work content of the job.

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| Course Code | : | BTMR1505T |
| Course Title | : | Kinematics and Theory of Machines |
| Number of Credits | : | 3 (L: 3; T: 0; P: 0) |
| Course Category | : | MT |

##### Course Objective:

* + To understand the kinematics and rigid body dynamics of kinematically driven machine components.
  + To understand the motion of linked mechanisms in terms of the displacement, velocity and acceleration at any point in a rigid link.
  + To be able to design some linkage mechanisms and cam systems to generate specified output motion.
  + To understand the kinematics of gear trains.

##### Course Contents:

**Module I:** Classification of mechanisms- Basic kinematic concepts and definitions- Degree of freedom, mobility- Grashof’s law, Kinematic inversions of four bar chain and slider crank chains- Limit positions- Mechanical advantage- Transmission angle- Description of some common mechanisms- Quick return mechanism, straight line generators- Universal Joint- Rocker mechanisms.

**Module II:** Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centres, velocity and acceleration analysis

using loop closure equations- kinematic analysis of simple mechanisms- slider crank mechanism dynamics.

**Module III:** Coincident points- Coriolis component of acceleration- introduction to linkage synthesis- three position graphical synthesis for motion and path generation.

**Module IV:** Classification of cams and followers- Terminology and definitions- Displacement diagrams- Uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions- specified contour cams- circular and tangent cams- pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile synthesis for roller and flat face followers.

Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting- helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics.

**Module V:** Surface contacts- sliding and rolling friction- friction drives- bearings and lubrication- friction clutches- belt and rope drives- friction in brakes.

##### Text Books:

1. Thomas Bevan, Theory of Machines, 3rdedition, CBS Publishers & Distributors,2005.
2. Cleghorn W.L., Mechanisms of Machines, Oxford University Press,2005.
3. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGrawHill,2009.
4. Ghosh A. and Mallick A.K., Theory of Mechanisms and Machines, Affiliated East- West Pvt. Ltd, New Delhi.

##### Alternative NPTEL/SWAYAM Course:

|  |  |  |  |
| --- | --- | --- | --- |
| **S. No.** | **NPTEL Course Name** | **Instructor** | **Host Institute** |
| 1 | Kinematics of Machines | Prof. Ashok K Mallik | IIT KANPUR |

**Course Outcomes:** After completing this course, the students can design various types of linkage mechanisms for obtaining specific motion and analyze them for optimal functioning.

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| --- | --- | --- |
| Course Code | : | BTMR1506T |
| Course Title | : | Entrepreneurship and Startups |
| Number of Credits | : | 3 (L: 3; T: 0; P: 0) |
| Course Category | : | HS |

##### Course Objective:

* Acquiring Entrepreneurial spirit and resourcefulness.
* Familiarization with various uses of human resource for earning dignified means of living.
* Understanding the concept and process of entrepreneurship - its contribution and role in the growth and development of individual and the nation.
* Acquiring entrepreneurial quality, competency, and motivation.
* Learning the process and skills of creation and management of entrepreneurial venture.

##### Course Content:

**Module I: Introduction to Entrepreneurship and Start – Ups**

* Definitions, Traits of an entrepreneur, Intrapreneurship, Motivation
* Types of Business Structures, Similarities/differences between entrepreneurs and managers.

##### Module II: Business Ideas and their implementation

* Discovering ideas and visualizing the business
* Activity map
* Business Plan

##### Module III: Idea to Start-up

* Market Analysis – Identifying the target market,
* Competition evaluation and Strategy Development,
* Marketing and accounting,
* Risk analysis

##### Module IV: Management

* Company’s Organization Structure,
* Recruitment and management of talent.
* Financial organization and management

##### Module V: Financing and Protection of Ideas

* Financing methods available for start-ups in India
* Communication of Ideas to potential investors – Investor Pitch
* Patenting and Licenses

##### Module VI: Exit strategies for entrepreneurs, bankruptcy, and succession and harvesting strategy.

**Text Books/References:**

|  |  |  |  |
| --- | --- | --- | --- |
| **S. No.** | **Title of Book** | **Author** | **Publication** |
| 1 | The Startup Owner’s Manual: The Step-by-Step Guide for Building a Great Company | Steve Blank and Bob Dorf | K & S Ranch  ISBN – 978-0984999392 |
| 2 | The Lean Startup: How Today’s Entrepreneurs Use Continuous  Innovation to Create Radically Successful Businesses | Eric Ries | Penguin UK  ISBN – 978-0670921607 |
| 3 | Demand: Creating What People Love Before They Know They Want It | Adrian J. Slywotzky with Karl Weber | Headline Book Publishing ISBN – 978-0755388974 |

|  |  |  |  |
| --- | --- | --- | --- |
| 4 | The Innovator’s Dilemma: The Revolutionary Book That Will  Change the Way You Do Business | Clayton M. Christensen | Harvard business ISBN: 978-142219602 |

##### Websites:

* 1. <https://www.fundable.com/learn/resources/guides/startup>
  2. [https://corporatefinanceinstitute.com/resources/knowledge/finance/corporate](https://corporatefinanceinstitute.com/resources/knowledge/finance/corporate-structure/)

[-structure/](https://corporatefinanceinstitute.com/resources/knowledge/finance/corporate-structure/)

* 1. <https://www.finder.com/small-business-finance-tips>
  2. [https://www.profitbooks.net/funding-options-to-raise-startup-capital-for-your-](https://www.profitbooks.net/funding-options-to-raise-startup-capital-for-your-business/) [business/](https://www.profitbooks.net/funding-options-to-raise-startup-capital-for-your-business/)

**Course Outcomes:** Upon completion of the course, the student will be able:

1. To Understand the dynamic role of entrepreneurship and small businesses
2. To Organize and Managing a Small Business
3. To do Financial Planning and Control
4. To Forms of Ownership for Small Business
5. To develop Strategic Marketing Planning
6. To illustrate New Product or Service Development
7. To illustrate Business Plan Creation

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| --- | --- | --- |
| Course Code | : | BTHM1501T |
| Course Title | : | Indian Constitution |
| Number of Credits | : | 0 (L: 2; T: 0; P: 0) |
| Course Category | : | AU |

##### Course Content

**Module I**: **The Constitution - Introduction**

* + The History of the Making of the Indian Constitution
  + Preamble and the Basic Structure, and its interpretation
  + Fundamental Rights and Duties and their interpretation
  + State Policy Principles

##### Module II – Union Government

* + Structure of the Indian Union
  + President – Role and Power
  + Prime Minister and Council of Ministers
  + Lok Sabha and Rajya Sabha

##### Module III – State Government

* + Governor – Role and Power
  + Chief Minister and Council of Ministers
  + State Secretariat

##### Module IV – Local Administration

* + District Administration
  + Municipal Corporation
  + Zila Panchayat

##### Module V – Election Commission

1. Role and Functioning
2. Chief Election Commissioner
3. State Election Commission

##### Text Books/Suggested Learning Resources:

|  |  |  |  |
| --- | --- | --- | --- |
| **S. No.** | **Title of Book** | **Author** | **Publication** |
| 1 | Ethics and Politics of the Indian Constitution | Rajeev Bhargava | Oxford University Press, New Delhi, 2008 |
| 2 | The Constitution of India | B.L. Fadia | Sahitya Bhawan; New edition (2017) |
| 3 | Introduction to the Constitution of India | DD Basu | Lexis Nexis; Twenty-Third 2018 edition |

**Suggested Software/Learning Websites:**

1. <https://www.constitution.org/cons/india/const.html>
2. <http://www.legislative.gov.in/constitution-of-india>
3. <https://www.sci.gov.in/constitution>
4. [https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of-](https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of-india/) [india/](https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of-india/)

##### Alternative NPTEL/SWAYAM Course:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S. No.** | **NPTEL ID** | **NPTEL Course Name** | **Instructor** | **Host Institute** |
| 1 | 12910600 | CONSTITUTION OF INDIA AND ENVIRONMENTAL GOVERNANCE: ADMINISTRATIVE AND  ADJUDICATORY PROCESS | PROF. SAIRAM BHAT, PROF. M.  K. RAMESH | NATIONAL LAW SCHOOL OF INDIA UNIVERSITY |

**Course Outcomes:** Upon completion of this course, the students will be able:

* 1. To Understand the emergence and evolution of Indian Constitution.
  2. To Understand the structure and composition of Indian Constitution
  3. To Understand and analyse federalism in the Indian context.
  4. To Analyse Panchayati Raj institutions as a medium of decentralization
  5. To Understand and analyse the three organs of the state in the contemporary scenario.
  6. To Understand and Evaluate the Indian Political scenario amidst the emerging challenges.

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| Course Code | : | BTMR1501P |
| Course Title | : | Digital Signal Processing Lab |
| Number of Credits | : | 1 (L: 0; T: 0; P: 2) |
| Course Category | : | MT |

**Course Objective:** The objective of the course is practical implementation of the convolution, correlation, DFT, IDFT, Block convolution, Signal smoothing, filtering of long duration signals, and Spectral analysis of signals.

##### List of Experiments:

1. To study about DSP Processors and its architecture.
2. Introduction to MATLAB and IDE for processor development.
3. Introduction to Scilab Open Source Software.
4. Write a Program for the generation of basic signals such as Module impulse, Module step, ramp, exponential, sinusoidal and cosine.
5. To study matrix multiplication using code composer studio.
6. Evaluate 4 point DFT of and IDFT of x(n) = 1, 0 ≤ n ≤ 3; 0 elsewhere.
7. To implement the FFT algorithm.
8. Verify Blackman and Hamming windowing techniques.
9. Implement IIR Butterworth analog Low Pass for a 4 KHz cut off frequency.
10. Verify Circular Convolution using code composer studio.
11. Verify Linear convolution of two sequences using code composer studio.
12. To implement Tone Generation.
13. To implement floating point arithmetic.

##### EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

|  |  |  |
| --- | --- | --- |
| **S. No.** | **Experiment Name** | **Experiment Link(s)** |
| 1 | Implement IIR Butterworth analog Low Pass for a 4 KHz cut off frequency. | [http://vlabs.iitkgp.ernet.in/dsp/exp](http://vlabs.iitkgp.ernet.in/dsp/exp10/index.html) [10/index.html](http://vlabs.iitkgp.ernet.in/dsp/exp10/index.html) |

**Text Books/References:**

1. John G. Proakis, “Digital signal processing: principles algorithms and applications Using Matlab”. Pearson Education India.
2. Mitra, Sanjit Kumar, and Yonghong Kuo. Digital signal processing: a computer-based approach, 2nd edition, Tata McGraw-Hill.
3. Alan V, Oppenheim, Ronald W., Schafer A. “Digital Signal Processing” PHI Publishers.

**Course Outcomes:** After studying this course the students would be able:

1. To Understand the handling of discrete/digital signals using MATLAB & related softwares.
2. To Understand the basic operations of Signal processing.
3. To Analyze the spectral parameter of window functions.
4. To Design IIR, and FIR filters for band pass, band stop, low pass and high pass filters.
5. To develop the signal processing algorithm using MATLAB & VLAB.

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| Course Code | : | BTMR1502P |
| Course Title | : | Sensors & Instrumentation Lab |
| Number of Credits | : | 1 (L: 0; T: 0; P: 2) |
| Course Category | : | MT |

**Course Objective:** This introduces the students with the theory and methods for conducting experimental work in the laboratory and calibration of various instruments for measuring pressure, temperature, displacement, speed, vibration etc.

##### List of Experiments:

1. Study of the characteristics of Capacitor Level Sensor for Level Measurement of a Liquid in a Tank.
2. Study of the characteristics of a Piezo Resistive Sensor for Pressure Measurement of a Liquid in a Tank.
3. Study of the characteristics of Resistance Temperature Detector (RTD)
4. Study of the characteristics of a Thermistor
5. Study of the characteristics of a Thermocouple
6. Study of the characteristics of a Magnetic Proximity sensor for Speed Measurement
7. Study of the characteristics and operation of Magnetic Sensor.
8. Study of the operation and characteristics of optical sensors

##### EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

|  |  |  |
| --- | --- | --- |
| **S. No.** | **Experiment Name** | **Experiment Link(s)** |
| 1 | Study of the characteristics of Capacitor Level Sensor for Level Measurement of a Liquid in a Tank. | [http://sl-](http://sl-coep.vlabs.ac.in/Capacitance/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab) [coep.vlabs.ac.in/Capacitance/Theor](http://sl-coep.vlabs.ac.in/Capacitance/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab) [y.html?domain=Electrical%20Engin](http://sl-coep.vlabs.ac.in/Capacitance/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab) [eering&lab=Welcome%20to%20Sen](http://sl-coep.vlabs.ac.in/Capacitance/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab) [sor%20Lab](http://sl-coep.vlabs.ac.in/Capacitance/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab) |
| 2 | Study of the characteristics of Resistance Temperature Detector (RTD). | [http://sl-](http://sl-coep.vlabs.ac.in/Rtd/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab) [coep.vlabs.ac.in/Rtd/Theory.html?d](http://sl-coep.vlabs.ac.in/Rtd/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab) [omain=Electrical%20Engineering&l](http://sl-coep.vlabs.ac.in/Rtd/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab) [ab=Welcome%20to%20Sensor%20](http://sl-coep.vlabs.ac.in/Rtd/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab) [Lab](http://sl-coep.vlabs.ac.in/Rtd/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab) |
| 3 | Study of the characteristics of a Thermistor. | [http://vlab.amrita.edu/?sub=1&brc](http://vlab.amrita.edu/?sub=1&brch=282&sim=1511&cnt=1) [h=282&sim=1511&cnt=1](http://vlab.amrita.edu/?sub=1&brch=282&sim=1511&cnt=1) |

|  |  |  |
| --- | --- | --- |
| 4 | Study of the characteristics of a Thermocouple. | [http://sl-](http://sl-coep.vlabs.ac.in/Thermocouple/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab) [coep.vlabs.ac.in/Thermocouple/The](http://sl-coep.vlabs.ac.in/Thermocouple/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab) [ory.html?domain=Electrical%20Engi](http://sl-coep.vlabs.ac.in/Thermocouple/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab) [neering&lab=Welcome%20to%20Se](http://sl-coep.vlabs.ac.in/Thermocouple/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab) [nsor%20Lab](http://sl-coep.vlabs.ac.in/Thermocouple/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab) |

**Text Books/References:**

1. J. Fraden, Handbook of Modern Sensors: Physical, Designs, and Applications, AIP Press, Springer
2. D. Patranabis, Sensors and Transducers, PHI Publication, New Delhi
3. Mechatronics- Ganesh S. Hegde, Published by University Science Press (An imprint of Laxmi Publication Private Limited).

##### Course Outcomes:

1. To Understand the concept of sensors and its characteristics.
2. To Understand the practical approach in design of technology based on different sensors
3. To Learn various sensor materials and technology used in designing sensors.
4. To describe different sensors working.
5. To Develop a sense for recognizing bad data and an intuition of how to resolve problems.

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| Course Code | : | BTMR1503P |
| Course Title | : | Control System Engineering Lab |
| Number of Credits | : | 1 (L: 0; T: 0; P: 2) |
| Course Category | : | MT |

**Course Objective:** To understand concepts of the mathematical modelling, feedback control and stability analysis in Time and Frequency domains.

##### List of Experiments:

1. Different Toolboxes in MATLAB, Introduction to Control Systems Toolbox or its equivalent open source freeware software like Scilab.
2. Determine transpose, inverse values of given matrix.
3. Plot the pole-zero configuration in s-plane for the given transfer function.
4. Determine the transfer function for a given closed loop system in block diagram representation.
5. Plot Module step response of given transfer function and find delay time, rise time, peak time and peak overshoot.
6. Determine the time response of the given system subjected to any arbitrary input.
7. Plot root locus of given transfer function, locate closed loop poles for different values of k. Also find out Wd and What for a given root.
8. Create the state space model of a linear continuous system.
9. Determine the State Space representation of the given transfer function.
10. Plot bode plot of given transfer function. Also determine the relative stability by measuring gain and phase margins.
11. Determine the steady state errors of a given transfer function.
12. Plot Nyquist plot for given transfer function and to discuss closed loop stability. Also determine the relative stability by measuring gain and phase margin.

##### Text Books/References:

1. Gopal, M., Digital Control System, Wiley Eastern (1986).
2. Nagrath, I.J. and Gopal, M., Control System Engineering, New Age International (P) Limited, Publishers (2003). Hall of India Private Limited (2001).
3. Ogata, K., Modern Control Engineering, Prentice.
4. Ambikapathy A., Control System, Khanna Book Publishing Company, 2018.

##### Course Outcomes:

After the successful completion of the course the students will be able:

1. To Develop the mathematical model of the physical systems.
2. To Analyze the response of the closed and open loop systems.
3. To Analyze the stability of the closed and open loop systems.
4. To Design the various kinds of compensator.
5. To Develop and analyze state space models.

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| --- | --- | --- |
| Course Code | : | BTMR1504P |
| Course Title | : | Mini Project or Internship |
| Number of Credits | : | 1 |
| Course Category | : | MT |

##### Mini Project or Internship of 3 to 4 Weeks shall be performed during summer break after semester IV and will be assessed as part of Semester V.

During the summer vacations, after the 4th Semester, students are required to be involved in Inter/ Intra Institution Activities viz.; Training with higher Institutions; Soft skill training organized by Training and Placement Cell of the respective institution; contribution at incubation/ innovation /entrepreneurship cell of the Institution; participation in conferences/ workshops/ competitions etc.; Learning at Departmental Lab/ Tinkering Lab/ Institutional workshop; Working for consultancy/ research project within the institutes and Participation in all the activities of Institute’s Innovations Council for e.g.: IPR workshop/ Leadership Talks/ Idea/ Design/ Innovation/ Business Completion/ Technical Expos etc.

After completion of Mini-project or Internship the student should prepare a comprehensive report to indicate what he has observed and learnt in the training period or while working on mini-project. The student may contact Industrial Supervisor/ Faculty Mentor/TPO for assigning special topics and problems and should prepare the final report on the assigned topics.

Student’s Diary and Internship Report should be submitted by the students along with attendance record and an evolution sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training. It will be evaluated on the basis of the following criteria:

* Regularity in maintenance of the diary.
* Adequacy & quality of information recorded.
* Drawing, sketches and data recorded.
* Thought process and recording techniques used.
* Organization of the information.

**Detailed 6th Semester Curriculum Contents**

**Undergraduate Degree in Engineering and Technology**

**BRANCH COURSE: MECHATRONICS ENGINEERING**

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| --- | --- | --- |
| Course Code | : | BTMR1601T |
| Course Title | : | Design of Machine Elements |
| Number of Credits | : | 3 (L: 3; T: 0; P: 0) |
| Course Category | : | MT |

##### Course Objective:

1. To develop an ability to apply knowledge of mathematics, science, and engineering.
2. To develop an ability to design a system, components to meet desired needs within realistic constraints.
3. To develop an ability to identify, formulate and solve engineering problems.
4. To develop an ability to use the technique, skills, & engineering tools.

##### Course Content:

**Module-I:** Design considerations - limits, fits and standardization, Review of failure theories for static and dynamic loading (including fatigue failure),

**Module-Ii:** Design of shafts under static and fatigue loadings, Analysis and design of sliding and rolling contact bearings,

**Module-III:** Design of transmission elements: spur, helical, bevel and worm gears; belt and chain drives,

**Module-IV:** Design of springs: helical compression, tension, torsional and leaf springs,

**Module-V:** Design of joints: threaded fasteners, pre-loaded bolts and welded joints, Analysis and applications of power screws and couplings, Analysis of clutches and brakes

##### Text Books/References:

1. Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw- Hill International; 1989.
2. Sadhu Singh, Machine Design, Khanna Book Publishing Company.
3. Sadhu Singh, Machine Design Data Book, Khanna Book Publishing Company.
4. Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan, 1992. Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley, 1994.
5. Spottes, M.F., Design of Machine elements, Prentice-Hall India, 1994.
6. R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall, 1998.

##### Alternative NPTEL/SWAYAM Course:

|  |  |  |  |
| --- | --- | --- | --- |
| **S. No.** | **NPTEL Course Name** | **Instructor** | **Host Institute** |
| 1. | Design of Machine Elements I | Prof. B. Maiti | IIT KHARAGPUR |

**Course Outcomes:** After the completion of this course, students will get an overview of the design methodologies employed for the design of various machine components.

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| --- | --- | --- |
| Course Code | : | BTMR1602T |
| Course Title | : | Computer Network & Cyber Security |
| Number of Credits | : | 3 (L: 3; T: 0; P: 0) |
| Course Category | : | MT |

##### Course Objective:

* To develop an understanding of modern network architectures from a design and performance perspective.
* To introduce the student to the major concepts involved in wide-area networks (WANs), local area networks (LANs) and Wireless LANs (WLANs).
* To provide an opportModuley to do network programming.
* To provide WLAN measurement ideas.

##### Course Content:

**Module I:** Data communication Components: Representation of data and its flow Networks, Various Connection Topology, Protocols and Standards, OSI model, Transmission Media, LAN: Wired LAN, Wireless LANs, Connecting LAN and Virtual LAN, Techniques for Bandwidth utilization: Multiplexing - Frequency division, Time division and Wave division, Concepts on spread spectrum.

**Module II:** Data Link Layer and Medium Access Sub Layer: Error Detection and Error Correction - Fundamentals, Block coding, Hamming Distance, CRC; Flow Control and Error control protocols - Stop and Wait, Go back – N ARQ, Selective Repeat ARQ, Sliding Window, Piggybacking, Random Access, Multiple access protocols -Pure ALOHA, Slotted ALOHA, CSMA/CD, CDMA/CA

**Module III:** Network Layer: Switching, Logical addressing – IPV4, IPV6; Address mapping

– ARP, RARP, BOOTP and DHCP–Delivery, Forwarding and Unicast Routing protocols. Transport Layer: Process to Process Communication, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), SCTP Congestion Control; Quality of Service, QoS improving techniques: Leaky Bucket and Token Bucket algorithm.

**Module IV:** Application Layer: Domain Name Space (DNS), DDNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls, Basic concepts of Cryptography. Cyber Security Concepts Essential Terminologies: CIA, Risks, Breaches,

Threats, Attacks, Exploits. Information Gathering (Social Engineering, Foot Printing & Scanning). Open Source/ Free/ Trial Tools: nmap, zenmap, Port Scanners, Network scanners.

**Module V:** Cyber Security Vulnerabilities & Safe Guards (8 Hours) Internet Security, Cloud Computing & Security, Social Network sites security, Cyber Security Vulnerabilities-Overview, vulnerabilities in software, System administration, Complex Network Architectures.

##### Text Books/References:

1. Data Communication and Networking, 4th Edition, Behrouz A. Forouzan, McGraw- Hill.
2. Data and Computer Communication, 8th Edition, William Stallings, Pearson Prentice Hall India.
3. Computer Networks, 8th Edition, Andrew S. Tanenbaum, Pearson New International Edition.
4. Internet working with TCP/IP, Volume 1, 6th Edition Douglas Comer, Prentice Hall of India.
5. TCP/IP Illustrated, Volume 1, W. Richard Stevens, Addison-Wesley, Moduleed States of America.

##### Alternative NPTEL/SWAYAM Course:

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| --- | --- | --- | --- |
| **S. No.** | **NPTEL Course Name** | **Instructor** | **Host Institute** |
| 1. | Computer Networks & Internet Protocol | Prof. Sandip Chakraborty | IIT Kharagpur |

**Course Outcomes:**

1. To Explain the functions of the different layers of the OSI Protocol.
2. To Draw the functional block diagram of wide-area networks (WANs), Local Area Networks (LANs) and Wireless LANs (WLANs) describe the function of each block.
3. To assess requirement (small scale) of wide-area networks (WANs), local area networks (LANs) and Wireless LANs (WLANs) design it based on the market available component.
4. To classify problem related TCP/IP protocol developed the network programming.
5. To Configure DNSDDNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls using open source available software and tools.

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| --- | --- | --- |
| Course Code | : | BTMR1603T |
| Course Title | : | Microprocessor & Microcontroller |
| Number of Credits | : | 3 (L: 3; T: 0; P: 0) |
| Course Category | : | MT |

**Course Objective:** To introduce the basics of microprocessors and microcontrollers technology and related applications. Study of the architectural details and programming of 16 bit 8085 microprocessors and its interfacing with various peripheral ICs; Study of architecture and programming of 8085 processors.

##### Course Content:

**Module I: 8085 MICROPROCESSOR**: History and Evolution of Microprocessor and their Classification, Architecture of 8085 Microprocessor, Address / Data Bus multiplexing and demultiplexing. Status and Control signal generation, Instruction set of 8085 Microprocessor, Classification of instructions, addressing modes, timing diagram of the instructions.

**Module II: Hardware Interfacing with 8085:** Methods of data Transfer and Interrupts of 8085 microprocessors: Classification of interrupts, Programming using interrupts, Direct Memory Access, Serial and parallel data transfer, Interfacing of Memory Chips with 8085 Microprocessor, Interfacing of 8085 with 8155/8156 (RAM), 8355/8755 (ROM). Interfacing of Programmable Devices with 8085 Microprocessor, 8279 programmable Keyboard/Display interface, 8255A programmable Parallel interface, 8254 programmable Interval Timer, 8259A programmable Interrupt Controller, Assembly language programming.

**Module III: 16-bit low power MCU:** Introduction to microcontrollers and embedded systems, Von Neumann (Princeton) and Harvard architecture, RISC and CISC machine, Architecture, Programming Techniques, Addressing Modes, Programming System registers and configuration I/O ports pull up/down registers concepts, Low Power aspects of MSP430: low power modes, Active vs Standby current consumption.

**Module IV: Configuring Peripherals in MSP430:** External interrupts and software interrupt, interrupt programming, Watchdog timer, Clock Tree in MSP430, Timer/ counter interrupt, Programming MSP430 timer, counter programming, Real Time Clock (RTC), PWM control, timing generation and measurements. Analog interfacing and data acquisition: ADC and Comparator in MSP430, data transfer using DMA.

**Module V: Serial Communication Interfaces in MSP430:** Basics of serial communication, mode of serial communication, RS232, serial communication issue, Serial port programming. Implementing and programming UART, I2C, SPI interface using MSP430, interfacing external devices, external memory, keyboards, display devices, DAC/ADC, DC Motor, Stepper Motor, Servomotor, power management, Sensor Interfacing and signal conditioning. Case Study: MSP430 based embedded system application using the interface protocols for communication with external devices: “A Low- Power Battery less Wireless Temperature and Humidity Sensor with Passive Low Frequency RFID.

##### Text Books:

1. Ramesh Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, Penram International Publication (India) Pvt. Ltd.
2. DV Hall, “Microprocessors Interfacing”, Tata McGraw Hill Publication.
3. N. Senthil Kumar, M. Saravanan, S. Jeevananthan, “Microprocessors and Microcontrollers”, Oxford University Press Publication.
4. Getting Started with the MSP430 Launchpad by Adrian Fernandez, Dung Dang, Newness publication ISBN-13: 978-0124115880
5. MSP430 microcontroller basics 1st Edition by John H. Davies (Author), Newnes Publication ISBN-13: 978-0750682763

##### References:

1. [http://processors.wiki.ti.com/index.php/MSP430\_LaunchPad\_Low\_Power\_Mode.](http://processors.wiki.ti.com/index.php/MSP430_LaunchPad_Low_Power_Mode)
2. [http://processors.wiki.ti.com/index.php/MSP430\_16-Bit\_Ultra-](http://processors.wiki.ti.com/index.php/MSP430_16-Bit_Ultra-Low_Power_MCU_Training) [Low\_Power\_MCU\_Training.](http://processors.wiki.ti.com/index.php/MSP430_16-Bit_Ultra-Low_Power_MCU_Training)
3. AK Roy & KM Bhurchandi, “Advance Microprocessor and Peripherals (Architecture, Programming & Interfacing)”, Tata McGraw Hill Publication.

**Course Outcomes:** The student will be able:

1. To Acquire knowledge about microprocessors and its need.
2. To Write the programs using 8085 and 8086 microprocessors.
3. To illustrate Know the internal architecture and interfacing of different peripheral devices with 8085 and 8086 microprocessors.
4. To Design the system using 8085 processors.

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| --- | --- | --- |
| Course Code | : | BTMR1604T |
| Course Title | : | Manufacturing Technologies |
| Number of Credits | : | 3 (L: 3; T: 0; P: 0) |
| Course Category | : | MT |

##### Course Objective:

1. To provide knowledge on machines and related tools for manufacturing various components.
2. To understand the relationship between process and system in manufacturing domain.
3. To identify the techniques for the quality assurance of the products and the optimality of the process in terms of resources and time management.

**MODULE I:** Patterns and Pattern making, Introduction to Foundry - Steps involved in casting, advantages, limitations and applications of casting process. Pattern types, allowances for pattern, pattern materials, color coding and storing of patterns Moulding, Moulding methods and processes-materials, equipment, Moulding sand ingredients, essential requirements, sand preparation and control, testing, cores and core making. Design considerations in casting, gating and Riser - directional solidification in castings, Metallurgical aspects of Casting

**MODULE II:** Casting Processes - Sand castings, pressure die casting, permanent mould casting, centrifugal casting, precision investment casting, shell Moulding, Co2 Moulding, continuous casting-squeeze casting, electro slag casting, Fettling and finishing, defects in Castings, Casting of non-ferrous materials Melting, Pouring and Testing , Melting furnaces- -crucibles oil fired furnaces-electric furnaces-cupola, selection of furnace, calculation of cupola charges-Degasification, inoculation, pouring techniques casting defects and Inspection of castings.

**MODULE III:** Cutting tools and tool geometry 8 Types of cutting tools, tool materials-HSS (including heat treatment) ceramics, cements, CBN &PCD, tool geometry and nomenclature, selection of tool materials and tool life, tool wear and machinability

Mechanics of clip formation, types of chips and conditions conducive for the formation of each type Built-up edge, its effects Orthogonal Vs oblique cutting- merchant’s force circle diagram. Force and velocity relationship, shear plane angle. Energy consideration in Machining-Ernst Merchant theory of shear angle, relationship-original assumptions and modification made.

**MODULE IV:** Extrusion and Drawing Processes, Classification of extrusion processes- tool, equipment, and principle of these processes, influence on Friction-Extrusion force calculation-defects and analysis-rod/wire drawing-tool, equipment and principle of processes.

Powder Metallurgy Introduction to Powder Metallurgy process, preparation of powders, types & function of binders, green compaction, sintering process and its effect on the product, application of powder metallurgy products, advantages of powder metallurgy products. Sintering equipment.

**MODULE V:** Basic Joining Processes Types of welding-gas welding, -arc welding, - shielded metal arc welding, GTAW, GMAW, SAW, ESW-Resistance welding (spot, seam, projection, percussion, flash types)-atomic hydrogen arc welding-thermit welding, Flame cutting - Use of Oxyacetylene, modern cutting processes, arc cutting.

Soldering, brazing and braze welding and their application., welding of special materials

–Stainless steel, aluminium etc. weldability of cast iron, steel, stainless steel, aluminium alloys. Introduction to Electron beam and Laser welding.

##### Text Books/References:

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)- Pearson India, 2014.
2. Kalpakjian and Schmid, Manufacturing Engineering and Technology, 6 ed., Pearson.
3. Lindberg, Processes & Materials of Manufacture, Prentice Hall India.
4. Kumar & Gupta, Manufacturing Processes, Prentice Hall India.
5. Jain, Production Technology, Khanna Publications.
6. Rao, Manufacturing Processes, McGraw Hill Education.
7. Taha H. A., Operations Research, 6th Edition, Prentice Hall of India,2003.
8. Shenoy G.V. and Shrivastava U.K., Operations Research for Management, Wiley

##### Alternative NPTEL/SWAYAM Course:

|  |  |  |  |
| --- | --- | --- | --- |
| **S. No.** | **NPTEL Course Name** | **Instructor** | **Host Institute** |
| 1. | Manufacturing Processes I | Dr. Pradeep Kumar | IIT ROORKEE |

**Course Outcomes:** Upon completion of this course, students will be able to the tooling needed for manufacturing, the dimensional accuracy and tolerances of products, assembly of different components and the application of optimization methods in manufacturing.

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| --- | --- | --- |
| Course Code | : | MTPE-60X |
| Course Title | : | Professional Elective I |
| Number of Credits | : | 3 (L: 3; T: 0; P: 0) |
| Course Category | : | MTPE |

Any one course from following may be opted as “Professional Elective I”:

1. Optimization Technique (MTPE-601)
2. Operation Research (MTPE-602)
3. Total Quality Management (MTPE-603)

##### Refer Appendix I on Professional Electives.

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| Course Code | : | BTMR1601P |
| Course Title | : | Computer Aided Design Lab |
| Number of Credits | : | 2 (L: 0; T: 0; P: 4) |
| Course Category | : | MT |

##### Course Objective:

* To impart fundamental knowledge to students in the latest technological topics on Computer Aided Design, Computer Aided Manufacturing and Computer Aided Engineering Analysis and to prepare them for taking up further research in the areas.
* To create a congenial environment that promotes learning, growth and imparts ability to work with inter-disciplinary groups in professional, industry and research organizations.
* To broaden and deepen their capabilities in analytical and experimental research methods, analysis of data, and drawing relevant conclusions for scholarly writing and presentation.
* To provide guidance to students for their choices in research and professional career outlook and to encourage students to take up research.

##### List of Experiments:

1. Geometric Transformation algorithm experiment for translation/rotation/scaling: Writing and validation of computer programs.
2. Design of machine components or other system experiments: Writing and validation of computer programs.
3. Understanding and use of any 3-D Modeling Software / commands.
4. Experiment: Solid modeling of a machine component using CAD Software.
5. Writing a small program for FEM for 2 spring system and validation of program or using a FEM Package
6. Numerical differentiation or numerical integration experiment: Writing and validation of computer programs.

##### Text Books/References:

1. Basu, S. K. and Pal, D.K., Design of Machine Tools, Allied Publishers (2008).
2. Acherkhan, N.S., Machine Tool Design, University Press of the Pacific, (2000).
3. Boothroyd G and Knight Wiston A., Fundamentals of Machining and Machine Tools, CRC Press (2005).
4. Sharma, P. C., A Text Book of Machine Tools & Tool Design, S. Chand Limited, (2005).

**Course Outcomes:** Upon completion of this course, students will be able: -

1. To develop solutions in the areas of Design and simulation in Mechanical Engineering.
2. To develop Have abilities and capabilities in applying computer software and hardware to mechanical design and manufacturing fields.
3. To Review and document the knowledge developed by scholarly predecessors and critically assess the relevant technological issues.
4. To Formulate relevant research problems; conduct experimental and/or analytical study and analyzing results with modern mathematical / scientific methods and use of software tools.
5. To Design and validate technological solutions to defined problems and communicate clearly and effectively for the practical application of their work.

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| --- | --- | --- |
| Course Code | : | BTMR1602P |
| Course Title | : | Computer Network & Cyber Security Lab |
| Number of Credits | : | 1 (L: 0; T: 0; P: 2) |
| Course Category | : | MT |

**Course Objective:** In this course, students will learn the fundamental principles of computer and network security by studying attacks on computer systems, network, and the Web. Students will learn how those attacks work and how to prevent and detect them. The course emphasizes "learning by doing", and requires students to conduct a series of lab exercises. Through these labs, students can enhance their understanding of the principles, and be able to apply those principles to solve real problems. After completion of the course, students should be able to possess the following skills:

* + be able to explain security principles,
  + be able to evaluate risks faced by computer systems,
  + be able to explain how various attacks work,
  + be able to describe and generalize various software vulnerabilities

##### List of Experiments:

1. Study of different wireless network components and features of any one of the Mobile Security Apps.
2. Study of the features of firewall in providing network security and to set Firewall Security in windows.
3. Steps to ensure Security of any one web browser (Mozilla Firefox/Google Chrome)
4. Study of different types of vulnerabilities for hacking websites / Web Applications.
5. Analysis the Security Vulnerabilities of E-commerce services.
6. Analysis the security vulnerabilities of E-Mail Application

##### Text Books/References:

1. Data Communication and Networking, 4th Edition, Behrouz A. Forouzan, McGraw- Hill.
2. Data and Computer Communication, 8th Edition, William Stallings, Pearson Prentice Hall India.
3. Computer Networks, 8th Edition, Andrew S. Tanenbaum, Pearson New International Edition.

##### Course Outcomes:

* To understand the basics of Computer Networks, Cyber Security and Various Protocols. He / She will be in a position to understand the World Wide Web concepts.
* To illustrate a network and flow of information further he/she can understand easily the concepts of network security, Mobile and ad hoc networks.

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|  |  |  |
| --- | --- | --- |
| Course Code | : | BTMR1603P |
| Course Title | : | Microprocessor & Microcontroller Lab |
| Number of Credits | : | 2 (L: 0; T: 0; P: 4) |
| Course Category | : | MT |

##### Course Objective:

* To expose students to the operation of a typical microprocessor (8085) trainer kit.
* To prepare the students to be able to solve different problems by developing different programs.
* To develop the quality of assessing and analyzing the obtained data.

##### List of Experiments:

**8086 Programs using kits and MASM**

1. Basic arithmetic and Logical operations
2. Move a data block without overlap
3. Code conversion, decimal arithmetic and Matrix operations.
4. Floating point operations, string manipulations, sorting and searching
5. Password checking, Print RAM size and system date
6. Counters and Time Delay

##### Peripherals and Interfacing Experiments using 8085 and 16 bit MCU.

1. Traffic light control.
2. Stepper motor control.
3. Digital clock 10. Keyboard and Display.
4. Printer status 12. Serial interface and Parallel interface.
5. A/D and D/A interface and Waveform Generation.

##### Text Books/References:

1. A K Ray and K M Bhurchandi, “Advanced Microprocessors & Peripherals”, 2nd ed., TMH, 2006.
2. Mohamed Ali Mazidi, Janice Gillispie Mazidi, “The 8051 microcontroller and embedded systems”, Pearson education, 2004.

**Course Outcomes:** At the end of the course, the students will be able

1. To Identify relevant information to supplement the Microprocessor and Microcontroller course.
2. To Set up programming strategies and select proper mnemonics and run their program on the training boards.
3. To Practice different types of programming keeping in mind technical issues and evaluate possible causes of discrepancy in practical experimental observations in comparison.
4. To Develop testing and experimental procedures on Microprocessor and Microcontroller analyze their operation under different cases.

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| --- | --- | --- |
| Course Code | : | BTMR1604S |
| Course Title | : | Manufacturing Technologies Lab |
| Number of Credits | : | 1 (L: 0; T: 0; P: 2) |
| Course Category | : | MT |

**Course Objective:** To Study and practice the various operations that can be performed in lathe, shaper, drilling, milling machines etc. and to equip with the practical knowledge required in the core industries.

##### List of Experiments:

1. Design of pattern & pattern making: At least one wooden pattern with proper calculations.
2. Making a green sand mould
   * One mould each on pit Moulding & split pattern.
   * At least two for different type of components with core and without core to be made.
3. Sand testing experiments to determine:
   * Grain Fineness Number
   * Green Strength
   * Permeability Test
   * Moisture content test
4. Study, understanding and working of simple destructive & non-destructive testing procedures used for castings.
5. Measurement of forces for orthogonal turning operation by tool dynamometer.
6. Visit to foundry – study of automation processes, Layout, Material handling equipment & other processes with preparation of report.
7. Study of the extrusion and drawing process – visit to industry with report presentation.
8. Welding Lab:
   * Preparation of simple shapes of metal sheets by gas cutting.
   * Preparation of specimen & welding of: Angle joint / T joint Lap joint / Butt joint (use of both Arc & Gas welding).
   * Study, understanding and working of simple destructive & non-destructive testing procedures used for welding.
   * Study on influence of welding parameters in Arc & Gas welding with demonstration.
9. Study of the extrusion and drawing process – visit to industry with report presentation.

##### Text Books/References:

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)- Pearson India, 2014.
2. Taha H. A., Operations Research, 6thEdition, Prentice Hall of India,2003.

##### EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

|  |  |  |
| --- | --- | --- |
| **S. No.** | **Experiment Name** | **Experiment Link(s)** |
| 1 | Manufacturing of simple sheet metal components using shearing and bending operations. | [http://msvs-dei.vlabs.ac.in/msvs-](http://msvs-dei.vlabs.ac.in/msvs-dei/SheetMetal.php) [dei/SheetMetal.php](http://msvs-dei.vlabs.ac.in/msvs-dei/SheetMetal.php) |

**Course Outcomes:** Upon the completion of this course the students will be able

1. To Demonstrate the safety precautions exercised in the mechanical workshop.
2. To contrast workpiece as per given shape and size using Lathe.
3. To illustrate Join two metals using arc welding.
4. To demonstrate Use sheet metal fabrication tools and make a simple tray and funnel.
5. To design Use different moulding tools, patterns and prepare sand moulds.

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| --- | --- | --- |
| Course Code | : | BTMR1605S |
| Course Title | : | Seminar |
| Number of Credits | : | 1 |
| Course Category | : | MT |

The objective of the seminar is to improve communication/presentation skills of students and develop his/her acquaintance with new and upcoming technologies including new and emerging processes. Faculty in-charge may select the appropriate topic for the student and fixup the time and duration of the presentation. Students are expected to improve their awareness of careers and their individual career goals through this activity.