**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 2022-2023)**

***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: TheoryP: PracticalE: Professional ElectiveO: Open ElectiveS: 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)**

**Third Semester**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **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 | BTMR1301T | Basic Concept of Mechatronics | 3 | 0 | 0 | 20 | 10 | 10 | 40 | 60 | 100 | 3 |
| 2 | BTMR1302T | Physics-II | 3 | 0 | 0 | 20 | 10 | 10 | 40 | 60 | 100 | 2 |
| 3 | BTMR1303T | Strength of Materials-I | 3 | 0 | 0 | 20 | 10 | 10 | 40 | 60 | 100 | 3 |
| 4 | BTMR1304T | Electrical Machines | 3 | 0 | 0 | 20 | 10 | 10 | 40 | 60 | 100 | 3 |
| 5 | BTMR1301T | Embedded Systems | 3 | 0 | 0 | 20 | 10 | 10 | 40 | 60 | 100 | 3 |
| 6 | BTHM1301T | Effective Technical Communication | 2 | 0 | 0 | 20 | 10 | 10 | 40 | 60 | 100 | 2 |
| **PRACTICALS** |
| 1 | BTMR1301P | Basic Mechatronics Lab | 0 | 0 | 2 | 20 | 10 | 10 | 40 | 60 | 100 | 1 |
| 2 | BTMR1302P | Strength of Materials Lab | 0 | 0 | 2 | 20 | 10 | 10 | 40 | 60 | 100 | 1 |
| 3 | BTMR1303P | Electrical Machines Lab | 0 | 0 | 2 | 20 | 10 | 10 | 40 | 60 | 100 | 1 |
| 4 | BTMR1304P | Embedded Systems Lab | 0 | 0 | 2 | 20 | 10 | 10 | 40 | 60 | 100 | 1 |
| 5 | BTMR1305P | Mini Project(Internship) | 0 | 0 | 2 | 20 | 10 | 10 | 40 | 60 | 100 | 1 |
| **TOTAL** | 17 | 0 | 10 | 220 | 110 | 110 | 440 | 660 | 1100 | 21 |

**Mini Project or internship (3-4 weeks) shall be conducted during summer break after semester II and will be assessed during semester III**

**Bachelor of Technology (Mechatronics)**

**Fourth Semester**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **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 | BTMR1402T | Fluid Mechanics | 3 | 0 | 0 | 20 | 10 | 10 | 40 | 60 | 100 | 3 |
| 2 | BTMR1404T | Analog and Digital Electronics | 3 | 0 | 0 | 20 | 10 | 10 | 40 | 60 | 100 | 3 |
| 3 | BTMR1403T | Computer Organization | 3 | 0 | 0 | 20 | 10 | 10 | 40 | 60 | 100 | 3 |
| 4 | BTMR1401T | Signal and Systems | 3 | 0 | 0 | 20 | 10 | 10 | 40 | 60 | 100 | 3 |
| 5 | BTMR1405T | Industrial Automation | 3 | 0 | 0 | 20 | 10 | 10 | 40 | 60 | 100 | 3 |
| 6 | BTHM1401T | Environmental System | 2 | 0 | 0 | 20 | 10 | 10 | 40 | 60 | 100 | 2 |
| **PRACTICALS** |
| 1 | BTMR1401P | Fluid Mechanics Lab  | 0 | 0 | 2 | 20 | 10 | 10 | 40 | 60 | 100 | 1 |
| 2 | BTMR1402P | Analog and Digital Electronics Lab | 0 | 0 | 2 | 20 | 10 | 10 | 40 | 60 | 100 | 1 |
| 3 | BTMR1403P | Industrial Automation Lab | 0 | 0 | 2 | 20 | 10 | 10 | 40 | 60 | 100 | 1 |
| 4 | BTMR1404P | Signal & System Lab | 0 | 0 | 2 | 20 | 10 | 10 | 40 | 60 | 100 | 1 |
| 5 | BTMR1405P | Industrial Visit | 0 | 0 | 2 | 20 | 10 | 10 | 40 | 60 | 100 | 1 |
| **Total** | 17 | 0 | 10 | 110 | 110 | 110 | 440 | 660 | 1100 | 22 |

**DETAILED 3rd -SEMESTER CURRICULUM CONTENTS**

**Undergraduate Degree in Engineering &Technology**

**BRANCH/COURSE: MECHATRONICS ENGINEERING**

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| --- | --- | --- |
| Course Code | : | BTMR1301T |
| Course Title | : | Basic Concepts of Mechatronics |
| Number of Credits | : | 3 (L: 3; T: 0; P: 0) |
| Course Category | : | MT |

**Course Objective:** This course aims at providing fundamental understanding about the basic elements of a mechatronics system, interfacing, and its practical applications.

##### Course Contents:

**Module I:** Introduction: Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronic approach, Integrated Product Design, Modeling, Analysis and Simulation, Man-Machine Interface.

**Module II:** Sensors and transducers: classification, Development in Transducer technology, Opto- Electronics-Shaft encoders, CD Sensors, Vision System, etc.

**Module III:** Drives and Actuators: Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor and Stepper motor, Drive circuits, open and closed loop control; Embedded Systems: Hardware Structure, Software Design and Communication, Programmable Logic Devices, Automatic Control and Real Time Control Systems

**Module IV:** Smart materials: Shape Memory Alloy, Piezoelectric and Magnetostrictive Actuators: Materials, Static and dynamic characteristics, illustrative examples for positioning, vibration isolation, etc.

**Module V:** Micromechatronic systems: Microsensors, Microactuators; Micro-fabrication techniques LIGA Process: Lithography, etching, Micro-joining etc. Application examples; Case studies Examples of Mechatronic Systems from Robotics Manufacturing, Machine Diagnostics, Road vehicles and Medical Technology.

##### Text/Reference Books:

1. Mechatronics System Design, Devdas Shetty & Richard A. Kolk, PWS Publishing Company (Thomson Learning Inc.).
2. Mechatronics: A Multidisciplinary Approach, William Bolton, Pearson Education
3. A Textbook of Mechatronics, R.K. Rajput, S. Chand & Company Private Limited
4. Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, William Bolton, Prentice Hall.

##### Alternative NPTEL/SWAYAM Course:

|  |  |  |  |
| --- | --- | --- | --- |
| **S. No.** | **NPTEL Course Name** | **Instructor** | **Host Institute** |
| 1. | Mechatronics & Manufacturing Automation | Dr. Shrikrishna N. Joshi | IIT Guwahati |

**Course Outcomes:** After undergoing this course the students is in a position to understand how mechatronics systems can be designed and developed.

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| --- | --- | --- |
| Course Code | : | BTMR1303T |
| Course Title | : | Strength of Materials |
| Number of Credits | : | 3 (L: 3; T: 0; P: 0) |
| Course Category | : | MT |

##### Course Objective:

* To understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, shafts, cylinders and spheres for various types of simple loads.
* To calculate the elastic deformation occurring in various simple geometries for different types of loading.

##### Course Contents:

**Module I:** Deformation in solids- Hooke’s law, stress and strain- tension, compression and shear stresses- elastic constants and their relations- volumetric, linear and shear strains- principal stresses and principal planes- Mohr’s circle.

**Module II:** Beams and type’s transverse loading on beams- shear force and bend moment diagrams- Types of beam supports, simply supported and over-hanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads.

**Module III:** Moment of inertia about an axis and polar moment of inertia, deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell’s reciprocal theorems.

**Module IV:** Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs.

**Module V:** Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure.

##### Text/Reference Books:

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.
2. D.S. Bedi, Strength of Materials, Khanna Book Publishing, 2017.
3. R. Subramanian, Strength of Materials, Oxford University Press, 2007.
4. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata McGraw-Hill Publishing Co. Ltd., New Delhi 2005.

##### Alternative NPTEL/SWAYAM Course:

|  |  |  |  |
| --- | --- | --- | --- |
| **S. No.** | **NPTEL Course Name** | **Instructor** | **Host Institute** |
| 1. | Strength of Materials | Dr. Satish C Sharma | IIT Roorkee |

**Course Outcomes:**

After completing the course, the students should be able:

* To recognize various types of loads applied on machine components of simple geometry and understand the nature of internal stresses that will develop within the components.
* To evaluate the strains and deformation that will result due to the elastic stresses developed within the materials for simple types of loading.

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| Course Code | : | BTMR1304T |
| Course Title | : | Electrical Machines |
| Number of Credits | : | 3 (L: 3; T: 0; P: 0) |
| Course Category | : | MT |

##### Course Objective:

* Understand the concepts of magnetic circuits.
* Understand the operation of ac and dc machines.
* Analyze the differences in operation of different dc and ac machine configurations.

##### Course Contents:

**Module I: DC Machines-I:** Basic construction of a DC machine, magnetic structure - stator yoke, stator poles, pole-faces or shoes, air gap and armature core, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, flux per pole, induced EMF in an armature coil. Armature winding and commutation - Elementary armature coil and commutator, lap and wave windings, construction of commutator, linear commutation Derivation of back EMF

equation, armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution with armature reaction.

**Module II: DC Machines –II:** Motoring and generation Armature circuit equation for motoring and generation, Types of field excitations - separately excited, shunt and series. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed. V-I characteristics and torque-speed characteristics of separately excited shunt and series motors. Speed control through armature voltage. Losses, load testing and back-to- back testing of DC machines.

**Module III: Induction Machines:** Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit. Phasor Diagram, Losses and Efficiency. parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors. Generator operation. Self-excitation. Doubly-Fed Induction Machines.

**Module IV: Single-phase induction motors:** Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications.

**Module V: Synchronous machines:** Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Operating characteristics of synchronous machines, V-curves. Salient pole machine - two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division.

##### Text/Reference Books:

1. A. E. Fitzgerald and C. Kingsley, “Electric Machinery”, McGraw Hill Education, 2013.
2. M. G. Say, “Performance and design of AC machines”, CBS Publishers, 2002.
3. P. S. Bhimbhra, “Electrical Machines”, Khanna Book Publishing House, 2018.
4. I. J. Nagrath and D. P. Kothari, “Electric Machines”, McGraw Hill Education, 2010.
5. A. S. Langsdorf, “Alternating current Machines”, McGraw Hill Education, 1984.
6. P. C. Sen, “Principles of Electric Machines and Power Electronics”, John Wiley & Sons, 2007.
7. P. S. Bhimbhra, “Power Electronics”, Khanna Publishers, 2017.

##### Alternative NPTEL/SWAYAM Course:

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| --- | --- | --- | --- |
| **S. No.** | **NPTEL Course Name** | **Instructor** | **Host Institute** |
| 1. | Electrical Machines | Prof. G. Bhuvaneshwari | IIT Delhi |

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

1. To understand the concepts of rotating magnetic fields.
2. To understand the operation of ac and dc machines.
3. To analyze performance characteristics of ac and dc machines.

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| --- | --- | --- |
| Course Code | : | BTMR1302T |
| Course Title | : | Physics-II |
| Number of Credits | : | 2 (L: 2; T: 0; P: 0) |
| Course Category | : | MT |

##### Course Objective:

* The course will provide the students about the electronic Components diode, transistor.
* This will provide the students the knowledge of IC fabrication.
* It gives an imp. Information about the optoelectronic devices.
* This course offered a variety of diodes like zener diode.
* It will give the knowledge of switching circuit.

##### Course Contents:

**Module I:** Review of semiconductor physics E-k diagram, Density of states, Occupation probability, Fermi level and quasi-Fermi level (variation by carrier concentration and temperature); p-n junction, Metal-semiconductor junction (Ohmic and Schottky); Carrier transport, generation, and recombination; Semiconductor materials of interest for optoelectronic devices, bandgap modification, heterostructures; Lightsemiconductor interaction: Rates of optical transitions, joint density of states, condition for optical amplification.

**Module II:** Semiconductor light emitting diodes (LEDs) (6) Rate equations for carrier density, Radiative and non-radiative recombination mechanisms in semiconductors, LED: device structure, materials, characteristics, and figures of merit.

**Module III:** Semiconductor lasers (8) Review of laser physics; Rate equations for carrier- and photon-density, and their steady state solutions, Laser dynamics, Relaxation oscillations, Input-output characteristics of lasers. Semiconductor laser: structure, materials, device characteristics, and figures of merit; DFB, DBR, and vertical-cavity surface-emitting lasers (VECSEL), Tunable semiconductor lasers.

**Module IV:** Photodetectors (6) Types of semiconductor photodetectors -p-n junction, PIN, and Avalanche --- and their structure, materials, working principle, and characteristics, Noise limits on performance; Solar cells.

**Module V:** Low-dimensional optoelectronic devices (6) Quantum-well, -wire, and -dot based LEDs, lasers, and photodetectors.

##### Text/Reference Books:

1. J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Inc. (1995).
2. B. E. A. Saleh and M. C. Teich, Fundamentals of Photonics, John Wiley & Sons.
3. S. M. Sze, Semiconductor Devices: Physics and Technology, Wiley (2008).
4. A. Yariv and P. Yeh, Photonics: Optical Electronics in Modern Communications, Oxford University Press, New York (2007).
5. P. Bhattacharya, Semiconductor Optoelectronic Devices, Prentice Hall of India (1997).
6. Online course: “Semiconductor Optoelectronics” by M R Shenoy on NPTEL.
7. Online course: "Optoelectronic Materials and Devices" by Monica Katiyar and Deepak Gupta on NPTEL.

**Course Outcomes:** After the completion of the course, Students will be able

1. To learn IC fabrication using many circuits as for the electronic industry.
2. To demonstrate the conversion of energy, like light to electrical energy using Optoelectronic devices
3. To learn semiconductor devices in the electronic field.
4. To illustrate Zener diode to control the voltage.

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| --- | --- | --- |
| Course Code | : | BTMR1301T |
| Course Title | : | Embedded Systems |
| Number of Credits | : | 3 (L: 3; T: 0; P: 0) |
| Course Category | : | MT |

##### Course Objective:

* + To understand the elements of embedded system.
	+ The ability to interface different components of embedded system and its programming.

**Course Contents:** The concept of embedded systems design, embedded microcontroller cores, embedded memories. Examples of embedded systems, Technological aspects of embedded systems: interfacing between analog and digital blocks, signal conditioning, digital signal processing. Sub-system interfacing, interfacing with external systems, user interfacing. Design trade-offs due to process compatibility, thermal considerations, etc., Software aspects of embedded systems: real time programming languages and operating systems for embedded systems.

##### Text/Reference Books:

1. J.W. Valvano, "Embedded Microcomputer System: Real Time Interfacing", Brooks/Cole, 2000.
2. Jack Ganssle, "The Art of Designing Embedded Systems", Newness, 1999.
3. V.K. Madisetti, "VLSI Digital Signal Processing", IEEE Press (NY, USA), 1995.
4. David Simon, "An Embedded Software Primer", Addison Wesley, 2000.
5. K.J. Ayala, "The 8051 Microcontroller: Architecture, Programming and Applications", Penram Intl, 1996.

##### Alternative NPTEL/SWAYAM Course:

|  |  |  |  |
| --- | --- | --- | --- |
| **S. No.** | **NPTEL Course Name** | **Instructor** | **Host Institute** |
| 1. | Embedded Systems | Prof. Shantanu Chaudhary | IIT Delhi |

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

1. To suggest design approach using advanced controllers to real-life situations.
2. To design interfacing of the systems with other data handling / processing systems.
3. To identify engineering constraints like energy dissipation, data exchange speeds etc.

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| --- | --- | --- |
| Course Code | : | BTHM1301T |
| Course Title | : | Effective Technical Communication |
| Number of Credits | : | 2 (L: 2; T: 0; P: 0) |
| Course Category | : | MT |

##### Course Content:

**Module I:** Information Design and Development- Different kinds of technical documents, Information development life cycle, Organization structures, factors affecting information and document design, Strategies for organization, Information design and writing for print and for online media.

**Module II:** Technical Writing, Grammar and Editing- Technical writing process, forms of discourse, writing drafts and revising, Collaborative writing, creating indexes, technical writing style and language. Basics of grammar, study of advanced grammar, editing strategies to achieve appropriate technical style. Introduction to advanced technical communication, Usability, Human factors, Managing technical communication projects, time estimation, Single sourcing, Localization.

**Module III:** Self Development and Assessment- Self assessment, Awareness, Perception and Attitudes, Values and belief, Personal goal setting, career planning, Self-esteem. Managing Time; Personal memory, Rapid reading, taking notes; Complex problem solving; Creativity.

**Module IV:** Communication and Technical Writing- Public speaking, Group discussion, Oral; presentation, Interviews, Graphic presentation, Presentation aids, Personality Development. Writing reports, project proposals, brochures, newsletters, technical articles, manuals, official notes, business letters, memos, progress reports, minutes of meetings, event report.

**Module V:** Ethics- Business ethics, Etiquettes in social and office settings, Email etiquettes, Telephone Etiquettes, Engineering ethics, managing time, Role and responsibility of engineer, Work culture in jobs, Personal memory, Rapid reading, taking notes, Complex problem solving, Creativity.

##### Text/Reference Books:

1. David F. Beer and David McMurrey, Guide to writing as an Engineer, John Willey. New York, 2004.
2. Diane Hacker, Pocket Style Manual, Bedford Publication, New York, 2003. (ISBN 0312406843).
3. Effective Communication Skills. Kulbhushan Kumar. Khanna Publishing House. 2018.
4. Shiv Khera, You Can Win, Macmillan Books, New York, 2003.
5. Raman Sharma, Technical Communications, Oxford Publication, London, 2004.
6. Dale Jungk, Applied Writing for Technicians, McGraw Hill, New York, 2004. (ISBN: 07828357-4)
7. Sharma, R. and Mohan, K. Business Correspondence and Report Writing, TMH New Delhi 2002.
8. Xebec, Presentation Book, TMH New Delhi, 2000. (ISBN 0402213).

##### Alternative NPTEL/SWAYAM Course:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S. No.** | **NPTEL ID** | **NPTEL Course Name** | **Instructor** | **Host Institute** |
| 1 | 102104061 | INTRODUCTION TO PROFESSIONAL SCIENTIFICCOMMUNICATION | PROF. S. GANESH | IIT KANPUR |

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| --- | --- | --- |
| Course Code | : | BTMR1301P |
| Course Title | : | Basic Mechatronics Lab |
| Number of Credits | : | 1 (L: 0; T: 0; P: 2) |
| Course Category | : | MT |

##### Course Objective:

* To synergies the combination of mechanical, electronics, control engineering and computer.
* Providing a focused laboratory environment to the engineering students to apply and absorb Mechatronics concepts.
* To provide a common ground where students could perform experimental study regarding fundamental sequence control by utilizing various sensors and actuators.

##### List of Experiments:

For first year students- Students can perform set of experiments as given below:

1. Identification and familiarization of the following components: resistors, inductors, capacitors, diodes, transistors, LED’s.
2. Familiarization with the following components: CRO, transformer, function generator, Multimeter, power supply.
3. Familiarization with the following electrical machines: Induction motors, DC motors, synchronous motors, single phase motors.
4. Familiarization with the following mechanical components: gears, gear train, bearings, couplings, tachometer
5. To study and design the PN junction diode and its use as half wave and full wave rectifier.
6. To design a voltage regulator using zener diode. Discuss the behavior of the regulator for various loads.
7. To verify truth tables of various logic gates and flip flops.
8. To study various sensors and transducers and compare with ideal characteristics.
9. To measure the characteristics of LVDT using linear displacement trainer kit.

##### Text/Reference Books:

1. Bolton, “Mechatronics”, Pearson, Singapore.
2. Mahalik, “Principles, concepts and applications Mechatronics”, TMH.
3. Ramesh Gaonkar, “Introduction to 8085-PENRAM”, International Publishing.
4. Muzumdar, “Pneumatics” –Tata McGraw-Hill Education.

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

|  |  |  |
| --- | --- | --- |
| **S. No.** | **Experiment Name** | **Experiment Link(s)** |
| 1 | Identification and familiarization of the following components: resistors, inductors, capacitors, diodes, transistors, LED’s. | 1. [http://vlabs.iitkgp.ernet.in/b](http://vlabs.iitkgp.ernet.in/be/exp1/index.html) [e/exp1/index.html](http://vlabs.iitkgp.ernet.in/be/exp1/index.html)
2. [http://vlabs.iitkgp.ernet.in/b](http://vlabs.iitkgp.ernet.in/be/exp3/index.html) [e/exp3/index.html](http://vlabs.iitkgp.ernet.in/be/exp3/index.html)
3. [http://vlabs.iitkgp.ernet.in/b](http://vlabs.iitkgp.ernet.in/be/exp2/index.html) [e/exp2/index.html](http://vlabs.iitkgp.ernet.in/be/exp2/index.html)
4. [http://vlabs.iitkgp.ernet.in/b](http://vlabs.iitkgp.ernet.in/be/exp5/index.html) [e/exp5/index.html](http://vlabs.iitkgp.ernet.in/be/exp5/index.html)
 |
| 2 | Familiarization with the following electrical machines: Induction motors, DC motors, synchronous motors, single phase motors. | [http://em-](http://em-coep.vlabs.ac.in/Exp8/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Electrical%20Machines) [coep.vlabs.ac.in/Exp8/Theory.html?](http://em-coep.vlabs.ac.in/Exp8/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Electrical%20Machines) [domain=Electrical%20Engineering&](http://em-coep.vlabs.ac.in/Exp8/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Electrical%20Machines) [lab=Welcome%20to%20Electrical%](http://em-coep.vlabs.ac.in/Exp8/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Electrical%20Machines) [20Machines](http://em-coep.vlabs.ac.in/Exp8/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Electrical%20Machines) |

|  |  |  |
| --- | --- | --- |
| 3 | To study and design the PN junction diode and its use as half wave and full wave rectifier. | [http://ee-iitb.vlabs.ac.in/ee-](http://ee-iitb.vlabs.ac.in/ee-iitb/exp1/index.html) [iitb/exp1/index.html](http://ee-iitb.vlabs.ac.in/ee-iitb/exp1/index.html) |
| 4 | To design a voltage regulator using zener diode. Discuss the behavior of the regulator for various loads. | [http://vlab.amrita.edu/?sub=1&brc](http://vlab.amrita.edu/?sub=1&brch=282&sim=1207&cnt=1) [h=282&sim=1207&cnt=1](http://vlab.amrita.edu/?sub=1&brch=282&sim=1207&cnt=1) |
| 5 | To verify truth tables of various logic gates and flip flops. | 1. [http://vlab.amrita.edu/index.](http://vlab.amrita.edu/index.php?sub=59&brch=165&sim=903&cnt=2) [php?sub=59&brch=165&sim](http://vlab.amrita.edu/index.php?sub=59&brch=165&sim=903&cnt=2)

[=903&cnt=2](http://vlab.amrita.edu/index.php?sub=59&brch=165&sim=903&cnt=2)1. [http://cse15-](http://cse15-iiith.vlabs.ac.in/exp6/Introduction.html?domain=Computer%20Science&lab=DLD%20Lab) [iiith.vlabs.ac.in/exp6/Introdu](http://cse15-iiith.vlabs.ac.in/exp6/Introduction.html?domain=Computer%20Science&lab=DLD%20Lab) [ction.html?domain=Compute](http://cse15-iiith.vlabs.ac.in/exp6/Introduction.html?domain=Computer%20Science&lab=DLD%20Lab) [r%20Science&lab=DLD%20L](http://cse15-iiith.vlabs.ac.in/exp6/Introduction.html?domain=Computer%20Science&lab=DLD%20Lab) [ab](http://cse15-iiith.vlabs.ac.in/exp6/Introduction.html?domain=Computer%20Science&lab=DLD%20Lab)
 |
| 6 | To measure the characteristics of LVDT using linear displacement trainer kit. | [http://sl-](http://sl-coep.vlabs.ac.in/LinearVariableDifferntialTransformer/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab) [coep.vlabs.ac.in/LinearVariableDiffe](http://sl-coep.vlabs.ac.in/LinearVariableDifferntialTransformer/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab) [rntialTransformer/Theory.html?do](http://sl-coep.vlabs.ac.in/LinearVariableDifferntialTransformer/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab) [main=Electrical%20Engineering&la](http://sl-coep.vlabs.ac.in/LinearVariableDifferntialTransformer/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab) [b=Welcome%20to%20Sensor%20L](http://sl-coep.vlabs.ac.in/LinearVariableDifferntialTransformer/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab) [ab](http://sl-coep.vlabs.ac.in/LinearVariableDifferntialTransformer/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab) |

**Course Outcomes:** After completing the course, students will be able:

1. To Identify the key elements of mechatronics system, representation into block diagram.
2. To apply knowledge of the concept of signal processing and signal conditioning for its industrial applications.
3. To analyze the requirements for a given industrial process and select the most appropriate Actuators, sensors, design circuit according to applications.
4. To understand the different logic gates, architecture of microprocessor and microcontroller for industrial applications.

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| --- | --- | --- |
| Course Code | : | BTMR1302P |
| Course Title | : | Strength of Materials Lab |
| Number of Credits | : | 1 (L: 0; T: 0; P: 2) |
| Course Category | : | MT |

**Course Objective:** Demonstrating the basic principles in the area of strength and mechanics of materials and structural analysis to the undergraduate students through a series of experiments is the objective of the strength of materials lab. Measuring the

properties of the materials such as impact strength, tensile strength, compressive strength, hardness, ductility is conducted in the lab.

Major Equipments Strength of Materials Lab: - Universal testing machine, Torsion testing machine, Impact testing machine, Brinell hardness testing machine, Rockwell hardness testing machine, etc.

##### List of Experiments:

1. Tension test
2. Bending tests on simply supported beam and Cantilever beam.
3. Torsion test
4. Hardness tests (Brinnel’s and Rockwell)
5. Tests on closely coiled and open coiled springs
6. Compression test on wood or concrete
7. Impact test
8. Shear test

##### Text/Reference Books:

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.
2. D.S. Bedi, Strength of Materials, Khanna Book Publishing Company, 2018.
3. R. Subramanian, Strength of Materials, Oxford University Press, 2007.
4. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata Mc GrawHill Publishing Co. Ltd., New Delhi 2005.

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

|  |  |  |
| --- | --- | --- |
| **S. No.** | **Experiment Name** | **Experiment Link(s)** |
| 1 | Tension test. | 1. <http://sm-nitk.vlabs.ac.in/exp13/index.html>
2. <http://sm-nitk.vlabs.ac.in/exp14/index.html>
 |
| 2 | Bending tests on simply supported beam and Cantilever beam. | 1. [https://mdmv-](https://mdmv-nitk.vlabs.ac.in/exp2/index.html) [nitk.vlabs.ac.in/exp2/index.html](https://mdmv-nitk.vlabs.ac.in/exp2/index.html)
2. [https://mdmv-](https://mdmv-nitk.vlabs.ac.in/exp3/index.html) [nitk.vlabs.ac.in/exp3/index.html](https://mdmv-nitk.vlabs.ac.in/exp3/index.html)
3. <http://sm-nitk.vlabs.ac.in/exp11/index.html>
 |
| 3 | Torsion test. | 1. [http://eerc01-](http://eerc01-iiith.vlabs.ac.in/exp4/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab) [iiith.vlabs.ac.in/exp4/Introduction.html?domai](http://eerc01-iiith.vlabs.ac.in/exp4/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab) [n=Civil%20Engineering&lab=Welcome%20to](http://eerc01-iiith.vlabs.ac.in/exp4/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab)

[%20Basic%20Engineering%20Mechanics%20](http://eerc01-iiith.vlabs.ac.in/exp4/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab) [and%20Strength%20of%20Materials%20lab](http://eerc01-iiith.vlabs.ac.in/exp4/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab)!1. <http://sm-nitk.vlabs.ac.in/exp19/index.html>
 |
| 4 | Hardness tests(Brinnel’s and Rockwell) | [1. http://eerc01-](http://eerc01-iiith.vlabs.ac.in/exp10/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab) [iiith.vlabs.ac.in/exp10/Introduction.html?dom](http://eerc01-iiith.vlabs.ac.in/exp10/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab) [ain=Civil%20Engineering&lab=Welcome%20to](http://eerc01-iiith.vlabs.ac.in/exp10/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab) |

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| --- | --- | --- |
|  |  | [%20Basic%20Engineering%20Mechanics%20](http://eerc01-iiith.vlabs.ac.in/exp10/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab) [and%20Strength%20of%20Materials%20lab](http://eerc01-iiith.vlabs.ac.in/exp10/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab)!2. <http://sm-nitk.vlabs.ac.in/exp20/index.html> |
| 5 | Tests on closely coiled and open coiled springs. | [http://eerc01-](http://eerc01-iiith.vlabs.ac.in/exp8/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab) [iiith.vlabs.ac.in/exp8/Introduction.html?domain=Civil](http://eerc01-iiith.vlabs.ac.in/exp8/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab)[%20Engineering&lab=Welcome%20to%20Basic%20](http://eerc01-iiith.vlabs.ac.in/exp8/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab) [Engineering%20Mechanics%20and%20Strength%20](http://eerc01-iiith.vlabs.ac.in/exp8/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab) [of%20Materials%20lab](http://eerc01-iiith.vlabs.ac.in/exp8/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab)! |
| 6 | Compression test on wood or concrete. | [http://eerc01-](http://eerc01-iiith.vlabs.ac.in/exp2/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab) [iiith.vlabs.ac.in/exp2/Introduction.html?domain=Civil](http://eerc01-iiith.vlabs.ac.in/exp2/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab)[%20Engineering&lab=Welcome%20to%20Basic%20](http://eerc01-iiith.vlabs.ac.in/exp2/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab) [Engineering%20Mechanics%20and%20Strength%20](http://eerc01-iiith.vlabs.ac.in/exp2/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab) [of%20Materials%20lab](http://eerc01-iiith.vlabs.ac.in/exp2/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab)! |
| 7 | Impact test. | 1. [http://eerc01-](http://eerc01-iiith.vlabs.ac.in/exp5/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%25) [iiith.vlabs.ac.in/exp5/Introduction.html?domai](http://eerc01-iiith.vlabs.ac.in/exp5/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%25) [n=Civil%20Engineering&lab=Welcome%20to](http://eerc01-iiith.vlabs.ac.in/exp5/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%25)

[%20Basic%20Engineering%20Mechanics%20](http://eerc01-iiith.vlabs.ac.in/exp5/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%25) [and%20Strength%20of%20Materials%](http://eerc01-iiith.vlabs.ac.in/exp5/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%25)1. <http://sm-nitk.vlabs.ac.in/exp5/index.html>
2. <http://sm-nitk.vlabs.ac.in/exp6/index.html>
 |
| 8 | Shear test. | 1. [http://eerc01-](http://eerc01-iiith.vlabs.ac.in/exp3/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab) [iiith.vlabs.ac.in/exp3/Introduction.html?domai](http://eerc01-iiith.vlabs.ac.in/exp3/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab) [n=Civil%20Engineering&lab=Welcome%20to](http://eerc01-iiith.vlabs.ac.in/exp3/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab)

[%20Basic%20Engineering%20Mechanics%20](http://eerc01-iiith.vlabs.ac.in/exp3/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab) [and%20Strength%20of%20Materials%20lab](http://eerc01-iiith.vlabs.ac.in/exp3/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab)!1. <http://sm-nitk.vlabs.ac.in/exp7/index.html>
2. <http://sm-nitk.vlabs.ac.in/exp8/index.html>
3. <http://sm-nitk.vlabs.ac.in/exp9/index.html>
 |

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

1. To Analyze and design structural members subjected to tension, compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain and elastic behavior of materials.
2. To Utilize appropriate materials in design considering engineering properties, sustainability, cost and weight.
3. To Perform engineering work in accordance with ethical and economic constraints related to the design of structures and machine parts.

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| --- | --- | --- |
| Course Code | : | BTMR1303P |
| Course Title | : | Electrical Machines Lab |

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| --- | --- | --- |
| Number of Credits | : | 1 (L: 0; T: 0; P: 2) |
| Course Category | : | MT |

##### Course Objective:

* Understand the concepts of magnetic circuits and their applications.
* Understand the operation of ac and dc machines and their characteristic curves.
* Analyze the differences in operation of different dc and ac machine configurations.

##### List of Experiments:

* 1. Performance characteristics of a D.C. Shunt motor.
	2. Speed control of dc shunt motor by varying armature circuit and field circuit method.
	3. Load test of D.C. shunt motor.
	4. Perform an open circuit test and block rotor test on a 3 phase IM to draw equivalent circuit.
	5. Perform load test on a universal motor and determine the performance with dc/ac supply voltage.
	6. Speed control of 3 phase Induction Motor.
	7. Determination of the performance characteristics of a three-phase induction motor by load test.
	8. Obtain a circle diagram of the given three-phase induction motor by conducting no load and blocked motor test and to determine the maximum torque, maximum power output.

##### Text/Reference Books:

1. A. E. Fitzgerald and C. Kingsley, “Electric Machinery”, McGraw Hill Education, 2013.
2. M. G. Say, “Performance and design of AC machines”, CBS Publishers, 2002.
3. P. S. Bhimbhra, “Electrical Machinery”, Khanna Publishers, 2011.
4. I. J. nagrath and D. P. Kothari, “Electric Machines”, McGraw Hill Education, 2010.
5. A. S. Langsdorf, “Alternating current Machines”, McGraw Hill Education, 1984.
6. P. C. Sen, “Principles of Electric Machines and Power Electronics”, John Wiley & Sons, 2007.

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

|  |  |  |
| --- | --- | --- |
| **S. No.** | **Experiment Name** | **Experiment Link(s)** |
| 1 | To obtain a circle diagram of the given three-phase induction motor by conducting no load and blocked motor test and to determine the maximum torque, maximum power output. | 1. [http://em-](http://em-coep.vlabs.ac.in/Exp3/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Electrical%20Machines) [coep.vlabs.ac.in/Exp3/Theory.html?doma](http://em-coep.vlabs.ac.in/Exp3/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Electrical%20Machines) [in=Electrical%20Engineering&lab=Welco](http://em-coep.vlabs.ac.in/Exp3/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Electrical%20Machines) [me%20to%20Electrical%20Machines](http://em-coep.vlabs.ac.in/Exp3/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Electrical%20Machines)
2. [http://em-](http://em-coep.vlabs.ac.in/Exp4/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Electrical%20Machines!) [coep.vlabs.ac.in/Exp4/Theory.html?doma](http://em-coep.vlabs.ac.in/Exp4/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Electrical%20Machines!) [in=Electrical%20Engineering&lab=Welco](http://em-coep.vlabs.ac.in/Exp4/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Electrical%20Machines!) [me%20to%20Electrical%20Machines!](http://em-coep.vlabs.ac.in/Exp4/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Electrical%20Machines!)
 |

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

1. To obtain performance characteristics of a D.C. Shunt motor.
2. To analyze speed control of dc shunt motor by varying armature circuit and field circuit method.
3. To perform an open circuit test and block rotor test on a 3 phase IM to draw equivalent circuit.
4. To perform load test on a universal motor and determine the performance with dc/ac supply voltage.
5. To Determine the performance characteristics of a three-phase induction motor by load test.
6. To obtain a circle diagram of the given three-phase induction motor by conducting no load and blocked motor test and to determine the maximum torque, maximum power output.

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| --- | --- | --- |
| Course Code | : | BTMR1304P |
| Course Title | : | Embedded Systems Lab |
| Number of Credits | : | 1 (L: 0; T: 0; P: 2) |
| Course Category | : | MT |

**Course Objective:** The student should be made to:

* Learn the working of ARM processor.
* Understand the Building Blocks of Embedded Systems.
* Learn the concept of memory map and memory interface.
* Know the characteristics of Real Time Systems.
* Write programs to interface memory, I/Os with processor.
* Study the interrupt performance.

##### List of Experiments:

1. Study of ARM evaluation system.
2. Interfacing ADC and DAC.
3. Interfacing LED and PWM.
4. Interfacing real time clock and serial port.
5. Interfacing keyboard and LCD.
6. Interfacing EPROM and interrupt.
7. Interrupt performance characteristics of ARM and FPGA.
8. Flashing of LEDS.
9. Interfacing stepper motor and temperature sensor.
10. Interfacing the wireless Modules with ARM.

##### Text/Reference Books:

1. J.W. Valvano, "Embedded Microcomputer System: Real Time Interfacing", Brooks/Cole, 2000.
2. Jack Ganssle, "The Art of Designing Embedded Systems", Newness, 1999.
3. V.K. Madisetti, "VLSI Digital Signal Processing", IEEE Press (NY, USA), 1995.

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

|  |  |  |
| --- | --- | --- |
| **S. No.** | **Experiment Name** | **Experiment Link(s)** |
| 1 | Interfacing ADC and DAC. | 1. [http://vlabs.iitkgp.ernet.in/rtes/exp4/inde](http://vlabs.iitkgp.ernet.in/rtes/exp4/index.html) [x.html](http://vlabs.iitkgp.ernet.in/rtes/exp4/index.html)
2. [http://vlabs.iitkgp.ernet.in/rtes/exp3/inde](http://vlabs.iitkgp.ernet.in/rtes/exp3/index.html) [x.html](http://vlabs.iitkgp.ernet.in/rtes/exp3/index.html)
 |
| 2 | Interfacing keyboard and LCD. | <http://vlabs.iitkgp.ernet.in/rtes/exp9/index.html> |
| 3 | Flashing of LEDs. | <http://vlabs.iitkgp.ernet.in/rtes/exp11/index.htm> |

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

1. To Write programs in ARM for a specific Application.
2. To Interface memory and Write programs related to memory operations.
3. To Interface A/D and D/A convertors with ARM system.
4. To Write programme for interfacing keyboard, display, motor and sensor.
5. To Analyse the performance of interrupt.

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| Course Code | : | BTMR1305P |
| 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 II and will be assessed as part of Semester III.

During the summer vacations, after the 2nd 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.

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**DETAILED 4th -SEMESTER CURRICULUM CONTENTS**

**Undergraduate Degree in Engineering &Technology**

 **BRANCH/COURSE: MECHATRONICS ENGINEERING**

|  |  |  |
| --- | --- | --- |
| Course Code | : | BTMR1402T |
| Course Title | : | Fluid Mechanics |
| Number of Credits | : | 3 (L: 3; T: 0; P: 0) |
| Course Category | : | MT |

##### Course Objective:

* To learn about the application of mass and momentum conservation laws for fluid flows
* To understand the importance of dimensional analysis
* To obtain the velocity and pressure variations in various types of simple flows
* To analyze the flow in water pumps and turbines.

##### Course Content:

**Module I:** Definition of fluid, Newton’s law of viscosity, Modules and Dimensions- Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension, Control volume- application of continuity equation and momentum equation, Incompressible flow, Bernoulli’s equation and its applications.

**Module II:** Exact flow solutions in channels and ducts, Couette and Poisuielle flow, laminar flow through circular conduits and circular annuli- concept of boundary layer – measures of boundary layer thickness – Darcy Weisbach equation, friction factor, Moody’s diagram.

**Module III:** Need for dimensional analysis – methods of dimension analysis – Similitude

– types of similitude Dimensionless parameters – application of dimensionless parameters – Model analysis.

**Module IV:** Euler’s equation – theory of Rotodynamic machines – various efficiencies – velocity components at entry and exit of the rotor, velocity triangles – Centrifugal pumps, working principle, work done by the impeller, performance curves – Cavitation in pumps- Reciprocating pump – working principle.

**Module V:** Classification of water turbines, heads and efficiencies, velocity triangles- Axial, radial and mixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines, working principles – draft tube- Specific speed, Module quantities, performance curves for turbines – governing of turbines.

##### Text/Reference Books:

1. Fluid Mechanics & Hydraulic Machines, S.S. Rattan, Khanna Book Publishing.
2. Fluid Mechanics and Machinery, C.S.P.Ojha, R. Berndtsson and P. N.

Chadramouli, Oxford University Press, 2010

1. Hydraulics and Fluid Mechanics, P M Modi and S M Seth, Standard Book House
2. Fluid Mechanics, Sadhu Singh, Khanna Publishing House.
3. Theory and Applications of Fluid Mechanics, K. Subramanya, Tata McGraw Hill
4. Fluid Mechanics with Engineering Applications, R.L. Daugherty, J.B. Franzini and E.J. Finnemore, International Student Edition, Mc Graw Hill

##### Alternative NPTEL/SWAYAM Course:

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| --- | --- | --- | --- |
| **S. No.** | **NPTEL Course Name** | **Instructor** | **Host Institute** |
| 1. | Fluid Mechanics | Prof. S.K. Som | IIT KHARAGPUR |

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

1. To analyze simple flow situations mathematically.
2. To evaluate the performance of pumps and turbines.

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| --- | --- | --- |
| Course Code | : | BTMR1404T |
| Course Title | : | Analog and Digital Electronics |
| Number of Credits | : | 3 (L: 3; T: 0; P: 0) |
| Course Category | : | MT |

**Course Objective:** This course will enable students to:

* Recall and Recognize construction and characteristics of JFETs and MOSFETs and differentiate with BJT
* Demonstrate and Analyze Operational Amplifier circuits and their applications
* Describe, Illustrate and Analyze Combinational Logic circuits, Simplification of Algebraic Equations using Karnaugh Maps and Quine McClusky Techniques.
* Describe and Design Decoders, Encoders, Digital multiplexers, Adders and Subtractors, Binary comparators, Latches and Master-Slave Flip-Flops.
* Describe, Design and Analyze Synchronous and Asynchronous Sequential
* Explain and design registers and Counters, A/D and D/A converters.

##### Course Content:

**Module-I: Field Effect Transistors:** Junction Field Effect Transistors, MOSFETs, Differences between JFETs and MOSFETs, Biasing MOSFETs, FET Applications, CMOS Devices. Wave-Shaping Circuits: Integrated Circuit(IC) Multi vibrators. Introduction to Operational Amplifier: Ideal v/s practical Op Amp, Performance Parameters, Operational Amplifier Application Circuits: Peak Detector Circuit, Comparator, Active Filters, Non Linear Amplifier, Relaxation Oscillator, Current-To-Voltage Converter, Voltage-To Current Converter.

**Module-II: The Basic Gates:** Review of Basic Logic gates, Positive and Negative Logic, Introduction to HDL. Combinational

**Logic Circuits:** Sum-of-Products Method, Truth Table to Karnaugh Map, Pairs Quads, and Octets, Karnaugh Simplifications, Don’t-care Conditions, Product-of-sums Method, Product-of-sums simplifications, Simplification by Quine-McClusky Method, Hazards and Hazard covers, HDL Implementation Models.

**Module-III: Data-Processing Circuits:** Multiplexers, Demultiplexers, 1-of-16 Decoder, BCD to Decimal Decoders, Seven Segment Decoders, Encoders, Exclusive-OR Gates, Parity Generators and Checkers, Magnitude Comparator, Programmable Array Logic, Programmable Logic Arrays, HDL Implementation of Data Processing Circuits. Arithmetic Building Blocks, Arithmetic Logic Module.

**Module-IV: Flip- Flops:** FLIP-FLOP Timing, JK Master-slave FLIP-FLOP, Switch Contact Bounce Circuits, Various Representation of FLIP-FLOPs, HDL Implementation of FLIP- FLOP.

**Registers:** Types of Registers, Serial In - Serial Out, Serial In - Parallel out, Parallel In - Serial Out, Parallel In - Parallel Out, Universal Shift Register, Applications of Shift Registers, Register implementation in HDL.

**Module-V: Counters:** Decade Counters, Preset table Counters, Counter Design as a Synthesis problem, A Digital Clock, Counter Design using HDL.

**D/A Conversion and A/D Conversion:** Variable, Resistor Networks, Binary Ladders, D/A Converters, D/A Accuracy and Resolution, A/D Converter-Simultaneous Conversion, A/D Converter-Counter Method, Continuous A/D Conversion, A/D Techniques, Dual- slope A/D Conversion, A/D Accuracy and Resolution.

##### Text/Reference Books:

1. A.K. Main & Nakul Maini, Analog Electronics, Khanna Book Publishing House (2018).
2. A.S. Sedra & K.C.Smith, Microelectronics Circuits, Oxford University Press (1997).
3. A.P. Malvino, Electronic Principles, Tata Mcgraw Hill Publications.
4. Robert L. Boylestad & Louis Nashelsky, Electronic Devices & Circuit Theory.
5. William Kleitz, Digital Electronics, Prentice Hall International Inc.

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

1. To understand the current voltage characteristics of semiconductor devices.
2. To analyze logic processes and implement logical operations using combinational logic circuits.
3. To understand of the fundamental concepts and techniques used in digital processing circuits.
4. To analyze, design and implement sequential logic circuits.
5. To apply the fundamental knowledge of analog and digital electronics to get different types of analog to digitalized signal and vice-versa converters in real world.

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| --- | --- | --- |
| Course Code | : | BTMR1403T |
| Course Title | : | Computer Organization |
| Number of Credits | : | 3 (L: 3; T: 0; P: 0) |
| Course Category | : | MT |

**Course Objective:** To expose the students to the following:

1. How Computer Systems work & the basic principles.
2. Instruction Level Architecture and Instruction Execution.
3. The current state of art in memory system design.
4. How I/O devices are accessed and its principles.
5. To provide the knowledge on Instruction Level Parallelism.
6. To impart the knowledge on micro programming.
7. Concepts of advanced pipelining techniques.

##### Course Content:

**Module I: Functional blocks of a computer:** CPU, memory, input-output subsystems, control Module. Instruction set architecture of a CPU – registers, instruction execution cycle, RTL interpretation of instructions, addressing modes, instruction set. Case study – instruction sets of some common CPUs.

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

##### Module II: Introduction to x86 architecture.

**CPU control Module design:** hardwired and micro-programmed design approaches, Case study – design of a simple hypothetical CPU.

**Memory system design:** semiconductor memory technologies, memory organization. **Peripheral devices and their characteristics:** Input-output subsystems, I/O device interface, I/O transfers program controlled, interrupt driven and DMA, privileged and non-privileged instructions, software interrupts and exceptions. Programs and processes – role of interrupts in process state transitions, I/O device interfaces – SCII, U.

**Module III: Pipelining:** Basic concepts of pipelining, throughput and speedup, pipeline hazards.

**Parallel Processors:** Introduction to parallel processors, Concurrent access to memory and cache coherency.

**Module IV: Memory organization:** Memory interleaving, concept of hierarchical memory organization, cache memory, cache size vs. block size, mapping functions, replacement algorithms, write policies.

##### Text/Reference Books:

1. **“**Computer Organization and Design**:** The Hardware/Software Interface” 5thEdition by David A. Patterson and John L. Hennessy, Elsevier.
2. Computer Organization and Embedded Systems, 6thEdition by Carl Hamacher, McGraw Hill Higher Education.
3. “Computer Architecture and Organization”, 3rdEdition by John P. Hayes, WCB/McGraw-Hill.

##### Alternative NPTEL/SWAYAM Course:

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| **S. No.** | **NPTEL Course Name** | **Instructor** | **Host Institute** |
| 1. | Computer Organization &Architecture: A Pedagogical Aspect | Dr. Arnab Sarkar | IIT Gowahati |
| 2. | Computer Architecture & Organisation | Prof. Indranil Sengupta Prof. Kamalika Datta | IIT Kharagpur |

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

1. To design a single bus architecture of a computer and describe the function of the instruction execution cycle, RTL interpretation of instructions, addressing modes, instruction set.
2. To write assembly language program for specified microprocessor for computing 16- bit multiplication, division and I/O device interface (ADC, Control circuit, serial port communication).
3. To predict flowchart for Concurrent access to memory and cache coherency in Parallel Processors and describe the process.
4. To design a memory Module and analyze its operation by interfacing with the CPU.
5. To assess its performance, and apply design techniques to enhance performance using pipelining, parallelism and RISC methodology.

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| Course Code | : | BTMR1401T |
| Course Title | : | Signals And Systems |
| Number of Credits | : | 3 (L: 3; T: 0; P: 0) |
| Course Category | : | MT |

**Course Objective:** The course will provide strong foundation on signals and systems which will be useful for creating foundation of communication and signal processing. The students will learn basic continuous time and discrete time signals and systems. Student

will understand application of various transforms for analysis of signals and systems both continuous time and discrete time. Students will also explore to power and energy signals and spectrum.

##### Course Content:

**Module I:** Basic definitions, Classification of signals and systems. Signal operations and properties. Basic continuous time signals, signal sampling and quantization, is cretization of continuous time signals, discrete time signals. Basic system properties, Representation of digital signals. Case study of different signals form communication and biomedical field.

**Module II:** Impulse response characterization and convolution integral for CT- LTI system, signal responses to CT-LTI system, properties of convolution, LTI system response properties from impulse response. (\*Review of Laplace transform with reference to CT signals and systems.)

**Module III:** Impulse response characterization and convolution sum, Causal signal response to DT-LTI systems. Properties of convolution summation, Impulse response of DT-LTI system. DT-LTI system properties from Impulse response. System analysis from difference equation model

**Module IV:** Representation of periodic functions, Fourier series, Frequency spectrum of a periodic signals, Fourier Transform, Relation between Laplace Transform and Fourier Transform and its properties. Introduction to DTFT and DFT

**Module V:** The z-Transform, Convergence of z-Transform, Basic z-Transform, Properties of z-Transform, Inverse z-Transform and Solving difference equation using z-Transform

##### Text/Reference Books:

1. Signals and Systems by Alan V. Oppenheim, Alan S. Wilsky and Nawab, Prentice Hall.
2. Signals and Systems by K. Gopalan, Cengage Learning (India Edition).
3. Signals and Systems by Michal J. Roberts and Govind Sharma, Tata Mc-Graw Hill Publications.
4. Signals and Systems by Simon Haykin and Bary Van Veen, Wiley- India Publications.
5. Linear Systems and Signals by B.P.Lathi, Oxford University Press.
6. Signal, Systems and Transforms by Charles L. Philips, J. M. Parr and E. A. Riskin, Pearson Education.
7. Digital Signal Processing Fundamentals and Applications by Li Tan, Elsevier, Academic Press.
8. Signal and Systems by Anand Kumar, 3rd Edition, PHI.

##### Alternative NPTEL/SWAYAM Course:

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| **S. No.** | **NPTEL Course Name** | **Instructor** | **Host Institute** |
| 1. | Signals & Systems | Prof. k.S. Venkatesh | IIT Kanpur |
| 2. | Signals & Sytems | Prof. V.M. Gadre | IIT Bombay |

**Course Outcomes:** After learning the course the students should be able:

* To Understand about various types of signals, classify them, analyze them, and perform various operations on them.
* To Understand about various types of systems, classify them, analyze them and understand their response behavior.
* To illustrate of transforms in analysis of signals and system.
* To rate signals and systems for observing effects of applying various properties and operations to Create strong foundation of communication and signal processing to be studied in the subsequent semester.

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| Course Code | : | BTMR1405T |
| Course Title | : | Industrial Automation |
| Number of Credits | : | 3 (L: 3; T: 0; P: 0) |
| Course Category | : | MT |

**Course Objective:** This course focuses on understanding various components of state of art automation technologies encountered in modern manufacturing industries. This course introduces the practical methods of automatic control of machines, processes and systems. All major parts of a modern industrial control system will be described and their principles explained.

##### Course Content:

**Module I: Factory Automation and Integration:** Basic concepts, types of automation, automation strategies, automation technologies, applications around us and in manufacturing industries.

**Module II: Design and Operation of Logic Control Circuits for Hydraulics and Pneumatics:** Basic elements of hydraulics/pneumatics, fluid power control elements and standard graphical symbols for them, hydraulic & pneumatic cylinders, hydraulic & pneumatic valves for pressure, flow & direction control, Circuit design approach and real time examples; sequence operation of two/more than two cylinders as per the design requirement to automate the systems. Hydraulics/pneumatic safety and their applications to clamping, traversing and releasing operations.

**Module III: Design and Operation of Electro-Pneumatic Logic Control Circuits:** Electro-pneumatic systems, solenoid valves, different sensors, factory automation sensors, electrical sensors, process automation sensors and their interfaces as per application criteria. Circuit design approach using relay logic circuits and real time examples; sequence operation of two/more than two cylinders as per the design

requirement to automate the systems. Electro pneumatic & electro hydraulic systems using relay logic circuits.

**Module IV: Industrial Control Systems:** Programmable Logic Controllers (PLC) based control system, programming languages & instruction set, ladder logic, functional blocks, structured text, and applications. Human Machine Interface (HMI) & Supervisory Control and Data Acquisition System (SCADA); motion controller, applications of RFID technology and machine vision.

**Module V: Research Micro Projects:** Students in a group will carry out micro project on design and implementation of an automatic modular system which can be useful in contemporary automation industries. The methodologies will be followed as first design and simulation of automated systems using Festo Fluid, SIM, SIROS, PLC software and then implementation by using pneumatic controls, electro-pneumatic controls, PLC and motion controls.

##### Text Books:

1. Groover, M. P., Automation, Production System & Computer Integrated Manufacturing, Pearson Education Asia (2009).
2. Esposito, A., Fluid Power with Applications, Sixth Edition, Pearson Education (2009).
3. Majumdar, S. R., Pneumatic Systems, McGraw Hill (2005).
4. Nakra, B. C., Theory and Applications of Automatic Controls, Revised 2nd Edition, New Age International Publishers (2014).
5. Morriss, S. B., Automated Manufacturing Systems, McGraw Hill (2006).
6. Auslander, D. M. and Kempf, C. J., Mechatronics: Mechanical System Interfacing.
7. Garry Dunning Programmable Logic Controller.
8. Programmable Logic Controllers by Frank Petruzella.

##### Alternative NPTEL/SWAYAM Course:

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| **S. No.** | **NPTEL Course Name** | **Instructor** | **Host Institute** |
| 1. | Industrial Automation & control | Prof. S. Mukhopadhyay | IIT Kharagpur |

**Course Outcomes:**

1. To demonstrated the knowledge of various devices used for industrial automation and their application, which will help students in their projects and knowledge in industry.
2. To learn terms, history, functions and principles of fluid power components in this automation technologies course. Control tactics, hydraulic interpretation, component symbols, pneumatic drawings and pneumatic circuit design are also examined. Students explore actuators and fluid transmission devices as well as the causes and consequences of fluid contamination.
3. To explore the programming and implementation of programmable logic controllers. Topics include the theories and application of hardware selection, configuration,

math blocks and troubleshooting. Students run industry-related simulations for PLC hardware and networking, related mechanisms, external device and operating cycle.

1. To illustrate the circuits used for automatic process controls of industrial systems.

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| Course Code | : | BTHM1401T |
| Course Title | : | Environmental System |
| Number of Credits | : | 2 (L: 2; T: 0; P: 0) |
| Course Category | : | AU |

**Course Objective:** People working in industries or elsewhere essentially require the knowledge of environmental science so as to enable them to work and produce most efficient, economical and eco-friendly finished products.

* Solve various engineering problems applying ecosystem to produce eco – friendly products.
* Use relevant air and noise control method to solve domestic and industrial problems.
* Use relevant water and soil control method to solve domestic and industrial problems.
* To recognize relevant energy sources required for domestic and industrial applications.
* Solve local solid and e-waste problems.

##### Course Content:

**Module I: Ecosystem**

* 1. Structure of ecosystem, Biotic & Abiotic components.
	2. Food chain and food web.
	3. Aquatic (Lentic and Lotic) and terrestrial ecosystem.
	4. Carbon, Nitrogen, Sulphur, Phosphorus cycle.
	5. Global warming -Causes, effects, process, Green House Effect, Ozone depletion.

##### Module II: Air and, Noise Pollution

1. Definition of pollution and pollutant, Natural and manmade sources of air pollution (Refrigerants, I.C., Boiler).
2. Air Pollutants: Types, Particulate Pollutants: Effects and control (Bag filter, Cyclone separator, Electrostatic Precipitator).
3. Gaseous Pollution Control: Absorber, Catalytic Converter, Effects of air pollution due to Refrigerants, I.C., Boiler.
4. Noise pollution: sources of pollution, measurement of pollution level, Effects of Noise pollution, Noise pollution (Regulation and Control) Rules, 2000.

##### Module III: Water and Soil Pollution

1. Sources of water pollution, Types of water pollutants, Characteristics of water pollutants Turbidity, pH, total suspended solids, total solids BOD and COD: Definition, calculation.
2. Waste Water Treatment: Primary methods: sedimentation, froth floatation, Secondary methods: Activated sludge treatment, Trickling filter, Bioreactor, Tertiary Method: Membrane separation technology, RO (reverse osmosis).
3. Causes, Effects and Preventive measures of Soil Pollution: Causes-Excessive use of Fertilizers, Pesticides and Insecticides, Irrigation, E-Waste.

##### Module IV: Renewable sources of Energy

1. Solar Energy: Basics of Solar energy. Flat plate collector (Liquid & Air). Theory of flat plate collector. Importance of coating. Advanced collector. Solar pond. Solar water heater, solar dryer. Solar stills.
2. Biomass: Overview of biomass as energy source. Thermal characteristics of biomass as fuel. Anaerobic digestion. Biogas production mechanism. Utilization and storage of biogas.
3. Wind energy: Current status and future prospects of wind energy. Wind energy in India. Environmental benefits and problem of wind energy.
4. 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.

##### Module V: Solid Waste Management, ISO 14000 & Environmental Management

1. Solid waste generation- Sources and characteristics of: Municipal solid waste, E- waste, biomedical waste.
2. Metallic wastes and Non-Metallic wastes (lubricants, plastics, rubber) from industries. Collection and disposal: MSW (3R, principles, energy recovery, sanitary landfill), Hazardous waste.
3. Air quality act 2004, air pollution control act 1981 and water pollution and control act1996. Structure and role of Central and state pollution control board.
4. Concept of Carbon Credit, Carbon Footprint.
5. Environmental management in fabrication industry.
6. ISO14000: Implementation in industries, Benefits.

##### Text Books/References:

1. S.C. Sharma & M.P. Poonia, Environmental Studies, Khanna Publishing House, New Delhi.
2. C.N. R. Rao, Understanding Chemistry, Universities Press (India) Pvt. Ltd., 2011.
3. Arceivala, Soli Asolekar, Shyam, Waste Water Treatment for Pollution Control and
4. Reuse, Mc-Graw Hill Education India Pvt. Ltd., New York, 2007, ISBN:978-07-062099-
5. Nazaroff, William, Cohen, Lisa, Environmental Engineering Science, Willy, New York, 2000, ISBN 10: 0471144940.
6. O.P. Gupta, Elements of Environmental Pollution Control, Khanna Publishing House, New Delhi
7. Rao, C. S., Environmental Pollution Control and Engineering, New Age International Publication, 2007, ISBN: 81-224-1835-X.
8. Rao, M. N.Rao, H.V.N, Air Pollution, Tata Mc-Graw Hill Publication, New delhi, 1988, ISBN: 0-07- 451871-8.
9. Frank Kreith, Jan F Kreider, Principles of Solar Engineering, McGraw-Hill, New York; 1978, ISBN: 9780070354760.
10. Aldo Vieira, Da Rosa, Fundamentals of renewable energy processes, Academic Press Oxford, UK; 2013. ISBN: 9780123978257.
11. Patvardhan, A.D, Industrial Solid Waste, Teri Press, New Delhi, 2013, ISBN:978-81- 7993-502-6
12. Metcalf & Eddy, Waste Water Engineering, Mc-Graw Hill, New York, 2013, ISBN: 077441206.
13. Keshav Kant, Air Pollution & Control, Khanna Publishing House, New Delhi (Edition 2018)

##### Open source software and website address:

1. [www.eco-prayer.org](http://www.eco-prayer.org/)
2. [www.teriin.org](http://www.teriin.org/)
3. [www.cpcp.nic.in](http://www.cpcp.nic.in/)
4. [www.cpcp.gov.in](http://www.cpcp.gov.in/)
5. [www.indiaenvironmentportal.org.in](http://www.indiaenvironmentportal.org.in/)
6. [www.whatis.techtarget.com](http://www.whatis.techtarget.com/)
7. [www.sustainabledevelopment.un.org](http://www.sustainabledevelopment.un.org/)
8. [www.conserve-energy-future.com](http://www.conserve-energy-future.com/)

##### Teachers should use the following strategies to achieve the various outcomes of the course.

* Different methods of teaching and media to be used to attain classroom attention.
* Massive open online courses (MOOCs) may be used to teach various topics/sub topics.
* 15-20% of the topics which are relatively simpler of descriptive in nature should be given to the students for self-learning and assess the development of competency through classroom presentations.
* Micro-projects may be given to group of students for hand-on experiences.
* Encouraging students to visit to sites such as Railway station and research establishment around the institution.

##### Alternative NPTEL/SWAYAM Course:

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| **S. No.** | **NPTEL ID** | **NPTEL Course Name** | **Instructor** | **Host Institute** |
| 1 | 127105018 | Introduction to Environmental Engineering and Science - Fundamental and Sustainability Concepts | Prof. Brajesh Kumar Dubey | IIT KGP |

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

1. To Understand the ecosystem and terminology and solve various engineering problems applying ecosystem knowledge to produce eco – friendly products.
2. To Understand the suitable air, extent of noise pollution, and control measures and acts.
3. To Understand the water and soil pollution, and control measures and acts.
4. To Understand different renewable energy resources and efficient process of harvesting.
5. To Understand Solid Waste Management, ISO 14000 & Environmental Management.

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| --- | --- | --- |
| Course Code | : | BTMR1401P |
| Course Title | : | Fluid Mechanics Lab |
| Number of Credits | : | 1 (L: 0; T: 0; P: 2) |
| Course Category | : | MT |

##### Course Objective:

* To teach basic principles of fluid mechanics.
* To teach and apply physical and mathematical methods used in analyzing engineering applications involving fluids.

##### List of Experiments:

1. Measurement of viscosity
2. Determination of co-efficient of friction of flow in a pipe
3. Determination of minor losses in flow through pipes
4. Application of momentum equation for determination of coefficient of impact of jets on flat and curved blades
5. Calibration of flow measuring devices:
	1. Orifice plate meter
	2. Nozzle meter
	3. Venturimeter
	4. V-notch
6. Study of Pressure Measuring Devices
7. Performance on hydraulic turbines: a) Pelton wheel b) Francis turbine c) Kaplan turbine.
8. Performance on hydraulic pumps: a) Single stage and multi stage centrifugal pumps

b) Reciprocating pump.

1. Venturimeter.

##### Text Books/References:

1. Fluid Mechanics & Hydraulic Machines, S.S. Rattan, Khanna Book Publishing.
2. Fluid Mechanics and Machinery, C.S.P.Ojha, R. Berndtsson and P. N. Chadramouli, Oxford University Press, 2010
3. Hydraulics and Fluid Mechanics, P M Modi and S M Seth, Standard Book House
4. Fluid Mechanics, Sadhu Singh, Khanna Publishing House.
5. Theory and Applications of Fluid Mechanics, K. Subramanya, Tata McGraw Hill
6. Fluid Mechanics with Engineering Applications, R.L. Daugherty, J.B. Franzini and E.J. Finnemore, International Student Edition, Mc Graw Hill

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

|  |  |  |
| --- | --- | --- |
| **S. No.** | **Experiment Name** | **Experiment Link(s)** |
| 1 | Measurement of viscosity. | [http://pcv-au.vlabs.ac.in/physical-](http://pcv-au.vlabs.ac.in/physical-chemistry/Determination_of_Viscosity_of_Organic_Solvents/) [chemistry/Determination\_of\_Viscosity\_of\_Org](http://pcv-au.vlabs.ac.in/physical-chemistry/Determination_of_Viscosity_of_Organic_Solvents/) [anic\_Solvents/](http://pcv-au.vlabs.ac.in/physical-chemistry/Determination_of_Viscosity_of_Organic_Solvents/) |
| 2 | Determination of coefficient of friction of flow in a pipe. | <http://fm-nitk.vlabs.ac.in/exp4/index.html> |
| 3 | Determination of minor losses in flow through pipes. | <https://mfts-iitg.vlabs.ac.in/PipeFlow.html> |
| 4 | Calibration of flow measuring devices: Orifice plate meter, Nozzle meter, Venturimeter, V-notch. | [http://virtual-labs.ac.in/fm-](http://virtual-labs.ac.in/fm-nitk/exp1/index.html) [nitk/exp1/index.html](http://virtual-labs.ac.in/fm-nitk/exp1/index.html) |
| 5 | Performance on hydraulic turbines: a) Pelton wheel b) Francis turbine c) Kaplan turbine. | 1. [http://fmc-nitk.vlabs.ac.in/fluid-](http://fmc-nitk.vlabs.ac.in/fluid-machinery-lab/exp/kaplan-turbine/) [machinery-lab/exp/kaplan-turbine/](http://fmc-nitk.vlabs.ac.in/fluid-machinery-lab/exp/kaplan-turbine/)
2. [http://fmc-nitk.vlabs.ac.in/fluid-](http://fmc-nitk.vlabs.ac.in/fluid-machinery-lab/exp/pelton-turbine/) [machinery-lab/exp/pelton-turbine/](http://fmc-nitk.vlabs.ac.in/fluid-machinery-lab/exp/pelton-turbine/)
3. [http://fmc-nitk.vlabs.ac.in/fluid-](http://fmc-nitk.vlabs.ac.in/fluid-machinery-lab/exp/francis-turbine/) [machinery-lab/exp/francis-turbine/](http://fmc-nitk.vlabs.ac.in/fluid-machinery-lab/exp/francis-turbine/)
 |
| 6 | Performance on hydraulic pumps: a) Single stage and multi stage centrifugal pumps b) Reciprocating pump. | [http://fmc-nitk.vlabs.ac.in/fluid-machinery-](http://fmc-nitk.vlabs.ac.in/fluid-machinery-lab/exp/centrifugal-pump/) [lab/exp/centrifugal-pump/](http://fmc-nitk.vlabs.ac.in/fluid-machinery-lab/exp/centrifugal-pump/) |
| 7 | Venturimeter. | <http://fm-nitk.vlabs.ac.in/exp5/index.html> |

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

1. To Understanding of basic physics of fluids.
2. To calculate and design engineering applications involving fluid.
3. To analyze flow of systems in terms of mass, momentum, and energy balance.
4. To assess Having knowledge about current research topics about fluid mechanics.

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| Course Code | : | BTMR1402P |
| Course Title | : | Analog and Digital Electronics Lab |
| Number of Credits | : | 1 (L: 0; T: 0; P: 2) |
| Course Category | : | MT |

##### Course Objective:

This course encompasses analog and digital electronic circuits from a circuit and monolithic (integrated circuit) implementation point of view. The objective of this course is to provide undergraduates with sufficient fundamental theoretical and practical knowledge to pursue advanced topics in analog and digital integrated circuits.

##### List of Experiments:

1. a. Design and construct a Schmitt trigger using Op-Amp for given UTP 1 and LTP values and demonstrate its working. b. Design and implement a Schmitt trigger using Op-Amp using a simulation package for two sets of UTP and LTP values and 3 demonstrate its working.
2. a. Design and construct a rectangular waveform generator (Op-Amp 5 relaxation oscillator) for given frequency. b. Design and implement a rectangular waveform generator (Op-Amp relaxation oscillator) using a simulation package and observe the change in frequency when all resistor values are doubled.
3. Design and implement a stable multivibrator circuit using 555 timers for a given frequency and duty cycle.
4. Design and implement Half adder, Full Adder, Half Subtractor, Full Subtractor using basic gates.
5. a. Given any 4-variable logic expression, simplify using Entered 16 Variable Map and realize the simplified logic expression using 8:1 multiplexer IC. b. Write the Verilog

/VHDL code for an 8:1 multiplexer. Simulate 18 and verify it’s working.

1. a) Design and implement code converter I) Binary to Gray II) Gray to Binary Code using basic gates.
2. Design and verify the Truth Table of 3-bit Parity Generator and 4-bit Parity Checker using basic logic gates with an even parity bit.
3. a. Realize a J-K Master/Slave Flip-Flop using NAND gates and verify its truth table. b. Write the Verilog/VHDL code for D Flip-Flop with positive-edge triggering. Simulate and verify it’s working.

**Text Books:** Sedra Adel S and Smith Kenneth Carless, Microelectronic Circuits, 5th Edition, Oxford University Press, 2004.

##### Reference Books:

1. A.K. Main & Nakul Maini, Analog Electronics, Khanna Book Publishing House (2018).
2. A.S. Sedra & K.C.Smith, Microelectronics Circuits, Oxford University Press (1997)
3. A.P. Malvino, Electronic Principles, Tata Mcgraw Hill Publications
4. Robert L. Boylestad & Louis Nashelsky, Electronic Devices & Circuit Theory
5. William Kleitz, Digital Electronics, Prentice Hall International Inc.

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

|  |  |  |
| --- | --- | --- |
| **S. No.** | **Experiment Name** | **Experiment Link(s)** |
| 1 | Design and implement Half adder, Full Adder, Half Subtractor, Full Subtractor using basic gates. | [http://vlabs.iitkgp.ernet.in/dec/exp](http://vlabs.iitkgp.ernet.in/dec/exp7/index.html) [7/index.html](http://vlabs.iitkgp.ernet.in/dec/exp7/index.html) |
| 2 | Design and implement code converterI) Binary to Gray II) Gray to Binary Code using basic gates. | [https://he-](https://he-coep.vlabs.ac.in/Experiment2/Theory.html?domain=ElectronicsandCommunications&lab=Hybrid%20Electronics%20Lab) [coep.vlabs.ac.in/Experiment2/Theor](https://he-coep.vlabs.ac.in/Experiment2/Theory.html?domain=ElectronicsandCommunications&lab=Hybrid%20Electronics%20Lab) [y.html?domain=ElectronicsandCom](https://he-coep.vlabs.ac.in/Experiment2/Theory.html?domain=ElectronicsandCommunications&lab=Hybrid%20Electronics%20Lab) [munications&lab=Hybrid%20Electr](https://he-coep.vlabs.ac.in/Experiment2/Theory.html?domain=ElectronicsandCommunications&lab=Hybrid%20Electronics%20Lab) [onics%20Lab](https://he-coep.vlabs.ac.in/Experiment2/Theory.html?domain=ElectronicsandCommunications&lab=Hybrid%20Electronics%20Lab) |
| 3 | Realize a J-K Master/Slave Flip-Flop using NAND gates and verify its truth table. | [http://vlabs.iitkgp.ernet.in/dec/exp](http://vlabs.iitkgp.ernet.in/dec/exp8/index.html) [8/index.html](http://vlabs.iitkgp.ernet.in/dec/exp8/index.html) |

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

1. To Use Various Electronic Devices like Cathode Ray Oscilloscope, Signal generators, Digital Trainer Kit, Multimeters and components like Resistors, Capacitors, Op amp and Integrated Circuit.
2. To Design and demonstrate various combinational logic circuits.
3. To Design and demonstrate various types of counters and Registers using Flipflops
4. To simulate package to design circuits.
5. To Understand the working and implementation of ALU.

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| --- | --- | --- |
| Course Code | : | BTMR1403P |
| Course Title | : | Industrial Automation Lab |
| Number of Credits | : | 1 (L: 0; T: 0; P: 2) |
| Course Category | : | MT |

##### Course Objective:

* This lab imparts skill and knowledge on Industrial automation with an exclusive training on hardware and software components to automate industrial and commercial applications.
* Candidates are trained on automation products like PLC, HMI and SCADA to control and monitor the plant and machine.
* Programme are to be developed to enhance the skill set of the participants on Hardware & Programming basics and servicing.

##### List of Experiments:

1. Study hardware and software used in PLC.
2. Implementation of logic gates in PLC.
3. Implementation of arithmetic instruction.
4. Implementation of on and off delay timers.
5. Study, understand and perform experiments on timers and counters.
6. Study and simulate analog function blocks.
7. Logic implementation for traffic control application.
8. Logic implementation for bottle filling application.
9. Direct control of double acting cylinder.
10. Indirect control of double acting cylinder.
11. Hydraulic pump/characteristic curve of variable displacement pump.
12. Single-rod cylinder/pressure intensification.

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

|  |  |  |
| --- | --- | --- |
| **S. No.** | **Experiment Name** | **Experiment Link(s)** |
| 1 | Study and simulate analog and digital function blocks. | [http://ial-](http://ial-coep.vlabs.ac.in/List%20of%20experiments.html?domain=Electrical%20Engineering) [coep.vlabs.ac.in/List%20of%20experiments.html?domai](http://ial-coep.vlabs.ac.in/List%20of%20experiments.html?domain=Electrical%20Engineering) [n=Electrical%20Engineering](http://ial-coep.vlabs.ac.in/List%20of%20experiments.html?domain=Electrical%20Engineering) |
| 2 | Study, understand and perform experiments on timers and counters. | [http://ial-](http://ial-coep.vlabs.ac.in/Expt3/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Industrial%20Automation%20Laboratory) [coep.vlabs.ac.in/Expt3/Theory.html?domain=Electrical](http://ial-coep.vlabs.ac.in/Expt3/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Industrial%20Automation%20Laboratory)[%20Engineering&lab=Welcome%20to%20Industrial%2](http://ial-coep.vlabs.ac.in/Expt3/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Industrial%20Automation%20Laboratory) [0Automation%20Laboratory](http://ial-coep.vlabs.ac.in/Expt3/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Industrial%20Automation%20Laboratory) |
| 3 | Logic implementation for traffic control application. | [http://ial-](http://ial-coep.vlabs.ac.in/Expt4/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Industrial%20Automation%20Laboratory) [coep.vlabs.ac.in/Expt4/Theory.html?domain=Electrical](http://ial-coep.vlabs.ac.in/Expt4/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Industrial%20Automation%20Laboratory)[%20Engineering&lab=Welcome%20to%20Industrial%2](http://ial-coep.vlabs.ac.in/Expt4/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Industrial%20Automation%20Laboratory) [0Automation%20Laboratory](http://ial-coep.vlabs.ac.in/Expt4/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Industrial%20Automation%20Laboratory) |
| 4 | Logic implementation for bottle filling application. | [http://ial-](http://ial-coep.vlabs.ac.in/Expt5/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Industrial%20Automation%20Laboratory) [coep.vlabs.ac.in/Expt5/Theory.html?domain=Electrical](http://ial-coep.vlabs.ac.in/Expt5/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Industrial%20Automation%20Laboratory)[%20Engineering&lab=Welcome%20to%20Industrial%2](http://ial-coep.vlabs.ac.in/Expt5/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Industrial%20Automation%20Laboratory) [0Automation%20Laboratory](http://ial-coep.vlabs.ac.in/Expt5/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Industrial%20Automation%20Laboratory) |
| 5 | Study hardware and software used in PLC. | [http://plc-](http://plc-coep.vlabs.ac.in/exp1/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Programmable%20Logic%20Controller%20Lab) [coep.vlabs.ac.in/exp1/Theory.html?domain=Electrical%](http://plc-coep.vlabs.ac.in/exp1/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Programmable%20Logic%20Controller%20Lab) [20Engineering&lab=Welcome%20to%20Programmable](http://plc-coep.vlabs.ac.in/exp1/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Programmable%20Logic%20Controller%20Lab)[%20Logic%20Controller%20Lab](http://plc-coep.vlabs.ac.in/exp1/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Programmable%20Logic%20Controller%20Lab) |

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| --- | --- | --- |
| 6 | Implementation of logic gates in PLC. | [http://plc-](http://plc-coep.vlabs.ac.in/exp2/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Programmable%20Logic%20Controller%20Lab) [coep.vlabs.ac.in/exp2/Theory.html?domain=Electrical%](http://plc-coep.vlabs.ac.in/exp2/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Programmable%20Logic%20Controller%20Lab) [20Engineering&lab=Welcome%20to%20Programmable](http://plc-coep.vlabs.ac.in/exp2/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Programmable%20Logic%20Controller%20Lab)[%20Logic%20Controller%20Lab](http://plc-coep.vlabs.ac.in/exp2/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Programmable%20Logic%20Controller%20Lab) |
| 7 | Implementation of arithmetic instruction. | [http://plc-](http://plc-coep.vlabs.ac.in/exp7/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Programmable%20Logic%20Controller%20Lab) [coep.vlabs.ac.in/exp7/Theory.html?domain=Electrical%](http://plc-coep.vlabs.ac.in/exp7/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Programmable%20Logic%20Controller%20Lab) [20Engineering&lab=Welcome%20to%20Programmable](http://plc-coep.vlabs.ac.in/exp7/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Programmable%20Logic%20Controller%20Lab)[%20Logic%20Controller%20Lab](http://plc-coep.vlabs.ac.in/exp7/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Programmable%20Logic%20Controller%20Lab) |
| 8 | Implementation of on and off delay timers. | [http://plc-](http://plc-coep.vlabs.ac.in/exp4/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Programmable%20Logic%20Controller%20Lab) [coep.vlabs.ac.in/exp4/Theory.html?domain=Electrical%](http://plc-coep.vlabs.ac.in/exp4/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Programmable%20Logic%20Controller%20Lab) [20Engineering&lab=Welcome%20to%20Programmable](http://plc-coep.vlabs.ac.in/exp4/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Programmable%20Logic%20Controller%20Lab)[%20Logic%20Controller%20Lab](http://plc-coep.vlabs.ac.in/exp4/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Programmable%20Logic%20Controller%20Lab) |

##### Text Books:

1. Esposito, A., Fluid Power with Applications, Sixth Edition, Pearson Education (2009).
2. Majumdar, S. R., Pneumatic Systems, McGraw Hill (2005).
3. Nakra, B. C., Theory and Applications of Automatic Controls, Revised 2nd Edition, New Age International Publishers (2014).
4. Garry Dunning: Programmable Logic Controller.

##### Course Outcomes:

1. To demonstrate the knowledge of various devices used for industrial automation and their application, which will help students in their projects and knowledge in industry.
2. To explain history, functions and principles of fluid power components in this automation technologies course. Control tactics, hydraulic interpretation, component symbols, pneumatic drawings and pneumatic circuit design are also examined. Students explore actuators and fluid transmission devices as well as the causes and consequences of fluid contamination.
3. To explore the programming and implementation of programmable logic controllers. Topics include the theories and application of hardware selection, configuration, math blocks and troubleshooting. Students run industry-related simulations for PLC hardware and networking, related mechanisms, external device and operating cycle.

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| Course Code | : | BTMR1404P |
| Course Title | : | Signals and Systems Lab |
| Number of Credits | : | 1 (L: 0; T: 0; P: 2) |
| Course Category | : | MT |

##### Course Objective:

1. To enable the student on how to approach solving Engineering problems using simulation tools.
2. To prepare the students to use and analyze MATLAB or other related softwares in their project works.
3. To provide a foundation in use of this software for real time applications.

##### List of Experiments:

1. Basic Operations on Matrices.
2. Generation of Various Signals and Sequences (Periodic and Aperiodic), such as Module Impulse, Module Step, Square, Saw tooth, Triangular, Sinusoidal, Ramp, Sinc.
3. Operations on Signals and Sequences such as Addition, Multiplication, Scaling, Shifting, Folding, Computation of Energy and Average Power.
4. Finding the Even and Odd parts of Signal/Sequence and Real and Imaginary parts of Signal.
5. Convolution between Signals and sequences.
6. Auto Correlation and Cross Correlation between Signals and Sequences.
7. Verification of Linearity and Time Invariance Properties of a given Continuous/Discrete System.
8. Computation of Module sample, Module step and Sinusoidal responses of the given LTI system and verifying its physical realizability and stability properties.
9. Gibbs Phenomenon.
10. Finding the Fourier Transform of a given signal and plotting its magnitude and phase spectrum.

**Text Books/References:** Institutes may design their own Lab Manual; MATLAB Math works software or any other related software may be used.

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

|  |  |  |
| --- | --- | --- |
| **S. No.** | **Experiment Name** | **Experiment Link(s)** |
| 1 | Finding the Even and Odd parts of Signal/Sequence and Real and Imaginary parts of Signal. | [http://ssl-](http://ssl-iitg.vlabs.ac.in/Signals%20and%20their%20properties%28objectives%29.html) [iitg.vlabs.ac.in/Signals%20and%20their](http://ssl-iitg.vlabs.ac.in/Signals%20and%20their%20properties%28objectives%29.html)[%20properties(objectives).html](http://ssl-iitg.vlabs.ac.in/Signals%20and%20their%20properties%28objectives%29.html) |
| 2 | Convolution between Signals and sequences. | [http://ssl-](http://ssl-iitg.vlabs.ac.in/Signals%20and%20their%20properties%205%28objectives%29.html) [iitg.vlabs.ac.in/Signals%20and%20their](http://ssl-iitg.vlabs.ac.in/Signals%20and%20their%20properties%205%28objectives%29.html)[%20properties%205(objectives).html](http://ssl-iitg.vlabs.ac.in/Signals%20and%20their%20properties%205%28objectives%29.html) |
| 3 | Auto Correlation and Cross Correlation between Signals and Sequences. | [http://ssl-](http://ssl-iitg.vlabs.ac.in/Signals%20and%20their%20properties%205%28objectives%29.html) [iitg.vlabs.ac.in/Signals%20and%20their](http://ssl-iitg.vlabs.ac.in/Signals%20and%20their%20properties%205%28objectives%29.html)[%20properties%205(objectives).html](http://ssl-iitg.vlabs.ac.in/Signals%20and%20their%20properties%205%28objectives%29.html) |
| 4 | Finding the Fourier Transform of a given signal and plotting its magnitude and phase spectrum. | [http://ssl-](http://ssl-iitg.vlabs.ac.in/Signals_exp3%28objectives%29.html) [iitg.vlabs.ac.in/Signals\_exp3(objectives).h](http://ssl-iitg.vlabs.ac.in/Signals_exp3%28objectives%29.html) [tml](http://ssl-iitg.vlabs.ac.in/Signals_exp3%28objectives%29.html) |

**Course Outcomes:** At the end of the course student will demonstrate:

1. Ability to express programming & simulation for engineering problems.
2. Ability to find importance of this software for Lab Experimentation.
3. Articulate importance of software’s in research by simulation work.
4. Ability to write basic mathematical, electrical, electronic problems in MATLAB.

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| --- | --- | --- |
| Course Code | : | BTMR1405P |
| Course Title | : | Industrial Visit |
| Number of Credits | : | 1 |
| Course Category | : | MT |

The objective of an industrial visit is to provide opportModuley to students to get an insight regarding internal working of companies. Industrial visit helps to combine theoretical knowledge with practical knowledge. Industrial visits may be organized in any of the nearby industries interested to share their processes with students for their learning.