VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY
*(Formerly Uttarakhand Technical University, Dehradun Established by Uttarakhand State Govt. wide Act no. 415 of 2005)*
*Suddhowala, PO-Chandanwadi, Premnagar, Dehradun, Uttarakhand (Website- www.uktech.ac.in)*

# SYLLABUS

**For**

## B.TECH.

# (Robotics and Automation Engineering)

## 2nd Year

Effective from – Session 2023-24

**B.TECH. (ROBOTICS AND AUTOMATION)** Curriculum Structure

**SEMESTER-III**

| Sl. No. | Subject Codes | Category | Subject | Periods | | | Evaluation Scheme | | | | | Subject Total | Credit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Sessional Exam | | | ESE | | | |
| | | | | L | T | P | CT | TA | Total | TE | PE | | |
| 1 | AHT-006 | BSC | Advanced Applied Mathematics | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 2 | AHT-007 | HSC | Technical Communication/Universal Human Values | 2 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| | AHT-008 | | | 3 | 0 | 0 | | | | | | | |
| 3 | RAT-001 | DC | Sensors and Instrumentation | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 4 | RAT-002 | DC | Materials Engineering | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 5 | RAT-003 | DC | Fundamentals of Mechatronics | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 6 | RAP-001 | DLC | Materials Engineering & Testing Lab | 0 | 0 | 2 | | 25 | 25 | | 25 | 50 | 1 |
| 7 | RAP-002 | DLC | Mechatronics Lab | 0 | 0 | 2 | | 25 | 25 | | 25 | 50 | 1 |
| 8 | RAP-003 | DLC | Machine Drawing & Solid Modelling Lab | 0 | 1 | 2 | | 25 | 25 | | 25 | 50 | 1 |
| 9 | RAP-004 | DLC | Internship-I/Mini Project-I* | 0 | 0 | 2 | | | 50 | | | 50 | 1 |
| 10 | CST-006/ CST-005 | NC | Cyber Security#/Python Programming# | 2 | 0 | 0 | 15 | 10 | 25 | 50 | | | |
| 11 | GP-03 | NC | General Proficiency | | | | | | 50 | | | | |
| | | | **Total** | | | | | | | | | **950** | **23** |
| 12 | **Open Elective (Optional)** | | | 3 | 1 | 0 | 30 | 20 | 50 | 50 | | | **4** |

*The Mini Project-I or Internship-I (3-4 weeks) conducted during summer break after II semester and will be assessed during III semester.

*For Lateral entry admitted students, need to complete a mini project during the 3rd semester course and its evaluation will be at the end of 3rd semester in place of Internship-I/ Mini Project-I (RAP-004).

*# The content of the course is based on the case studies.*

# Advanced Applied Mathematics (AHT-006)

**L T P: 3 1 0**

## Course Objectives

The course should enable the students to learn:

- The idea of Laplace transform of functions and their applications.
- The idea of Fourier transform of functions and their applications.
- To evaluate roots of algebraic and transcendental equations.
- Interpolation, numerical differentiation& integration and the solution of differential equations.
- Acquaintance with statistical analysis and techniques.

## Particulars

### Unit 1: Laplace Transform: (8 Hrs)

Definition of Laplace transform, Existence theorem, Laplace transforms of derivatives and integrals, Initial and final value theorems, Unit step function, Dirac- delta function, Laplace transform of periodic function, Inverse Laplace transform, Convolution theorem, Application to solve linear differential equations.

### Unit 2: Fourier Transforms (8 Hrs)

Fourier integral, Fourier sine and cosine integral, Complex form of Fourier integral, Fourier transform, Inverse Fourier transforms, Convolution theorem, Fourier sine and cosine transform, Applications of Fourier transform to simple one dimensional heat transfer equations.

### Unit 3: Solution of Algebraic & Transcendental Equations and Interpolation (8 Hrs)

Number and their accuracy, Solution of algebraic and transcendental equations: Bisection method, Iteration method, Newton-Raphson method and Regula-Falsi method. Rate of convergence of these methods (without proof), Interpolation: Finite differences, Relation between operators, Interpolation using Newton's forward and backward difference formula, Interpolation with unequal intervals: Newton's divided difference and Lagrange's formula.

### Unit 4: Numerical differentiation & Integration and Solution of ODE (8 Hrs)

Numerical Differentiation, Numerical integration: Trapezoidal rule, Simpson's 1/3rd and 3/8 rule, Runge-Kutta method of fourth order for solving first order linear differential equations, Milne's predicator-corrector method.

**Unit 5: Statistical Techniques (8 Hrs)**

Introduction: Measures of central tendency, Moments, Skewness, Kurtosis, Curve fitting: Method of least squares, Fitting of straight lines, Fitting of second degree parabola, Exponential curves. Correlation and rank correlation, Regression analysis: Regression lines of y on x and x on y, Regression coefficients, Properties of regressions coefficients and non-linear regression.

**Reference Books**

1. E. Kreyszig: Advanced Engineering Mathematics, John Wiley & Sons, 10th ed.

2. B.V. Ramana: Higher Engineering Mathematics, McGraw Hill.

3. Peter V.O'Neil: Advanced Engineering Mathematics, Cengage Learning,7 th ed.

4. B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, 44th ed.

5. T. Veerarajan: Engineering Mathematics (for semester III), McGraw Hill, 3rd ed.

6. R.K. Jain and S.R.K. Iyenger: Advance Engineering Mathematics, Narosa Publishing House, Std. ed.

7. P. Kandasamy, K. Thilagavathy, K. Gunavathi: Numerical Methods, S. Chand.

8. S.S. Sastry: Introductory methods of numerical analysis, Prentice Hall India, 5thed.

9. N.P. Bali and Manish Goyal: Computer Based Numerical and Statistical Techniques, Laxmi Publications, 5th ed.

10. J.N. Kapur: Mathematical Statistics, S. Chand & Company.

11. D.N. Elhance,V. Elhance & B.M. Aggarwal: Fundamentals of Statistics, Kitab Mahal.

**Course Outcomes**

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

**CO1:** Remember the concept of Laplace transform and apply in solving real life problems.

**CO2:** Apply the concept of Fourier transform to evaluate engineering problems.

**CO3:** Understand to evaluate roots of algebraic and transcendental equations.

**CO4:** Solve the problem related interpolation, differentiation, integration and the solution of differential equations.

**CO5:** Understand the concept of correlation, regression, moments, skewness and kurtosis and curve fitting.

## Technical Communication (AHT-007)

**L T P: 2 1 0**

**Course Objectives**

The course should enable the students to:

- Produce technical documents that use tools commonly employed by engineering and computer science professionals.
- Communicate effectively in a professional context, using appropriate rhetorical approaches for technical documents, adhering to required templates, and complying with constraints on document format.
- Clarify the nuances of phonetics, intonation and pronunciation skills.
- Get familiarized with English vocabulary and language proficiency.

**Particulars**

**Unit 1** **(8 Hrs)**

**Fundamentals of Technical Communication:** Technical Communication: Introduction, Features; Distinction between General and Technical Communication; The flow of Communication: Downward; upward, Lateral or Horizontal; Barriers to Communication, Importance of communication.

**Unit 2** **(8 Hrs)**

**Forms of Technical Communication:** Technical Report: Definition & importance; Thesis/Project writing: structure & importance; synopsis writing: Methods; Technical research Paper writing: Methods & style; Seminar & Conference paper writing; 7 Cs of effective business writing: concreteness, completeness, clarity, conciseness, courtesy, correctness, consideration.

**Unit 3** **(8 Hrs)**

**Technical Presentation: Strategies & Techniques:** Presentation: Forms; interpersonal Communication; Class Room presentation; style; method, Public Speaking: method; Techniques: Clarity of substance; emotion; Humour; Modes of Presentation; Overcoming Stage Fear: Confident speaking; Audience Analysis & retention of audience interest; Methods of Presentation: Interpersonal; Impersonal; Audience Participation: Quizzes & Interjections.

**Unit 4** **(8 Hrs)**

**Technical Communication Skills:** Interview skills; Group Discussion: Objective & Method; Seminar/Conferences Presentation skills: Focus; Content; Style; Argumentation skills: Devices: Analysis; Cohesion & Emphasis; Critical thinking; Nuances, exposition, narration and description.

**Unit 5** **(8 Hrs)**

**Kinesics & Voice Dynamics:** Kinesics: Definitions; importance; Features of Body Language; Voice Modulation: Quality, Pitch; Rhythm; intonation, pronunciation, articulation, vowel and consonants sounds.

## Reference Books

1. Technical Communication – Principles and Practices by Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2007, New Delhi.
2. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
3. Practical Communication: Process and Practice by L.U.B. Pandey; A.I.T.B.S. Publications India Ltd.; Krishan Nagar, 2014, Delhi.
4. Modern Technical Writing by Sherman, Theodore A (et.al); Apprentice Hall; New Jersey; U.S.
5. A Text Book of Scientific and Technical Writing by S.D. Sharma; Vikas Publication, Delhi.
6. Skills for Effective Business Communication by Michael Murphy, Harward University, U.S.
7. Business Communication for Managers by Payal Mehra, Pearson Publication, Delhi.

## Course Outcomes

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

**CO1:** Enabled to understand the nature and objective of Technical Communication relevant for the work place as Engineers.

**CO2:** Able to utilize the technical writing for the purposes of Technical Communication and its exposure in various dimensions.

**CO3:** Able to give imbibe inputs by presentation skills to enhance confidence in face of diverse audience.

**CO4:** Able to create a vast know-how of the application of the learning to promote their technical competence.

**CO5:** Enabling them to evaluate their efficacy as fluent & efficient communicators by learning the voice-dynamics.

## Universal Human Values (AHT-008)

**L T P: 3 0 0**

**Course Objectives:**

The course should enable the students for:

- Development of a holistic perspective based on self- exploration about themselves (human being), family, society and nature/existence.
- Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence.
- Strengthening of self-reflection.
- Development of commitment and courage to act.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction - Value Education:** Universal human values; self exploration, natural acceptance an experimental validation; Human aspirations, right understanding, relationship and physical facility, current scenario; Understanding and living in harmony at various levels.

**Unit 2** **(8 Hrs)**

**Harmony in the Human Being:** Understanding human being, needs of self (I) and body; body as an instrument of 'I'; characteristics and activities of 'I' and harmony in 'I'; harmony of I with the Body: Sanyam and Health, Physical needs an prosperity; Programs to ensure Sanyam and Health.

**Unit 3** **(8 Hrs)**

**Harmony in the Family and Society:** Values in human-human relationship; nine universal values in relationships; justice, truth, respect, trust; Difference between intention and competence; Respect and differentiation, Harmony in society: resolution, prosperity, fearlessness and coexistence; Universal harmonious order in society.

**Unit 4** **(8 Hrs)**

**Harmony in the Nature and Existence:** Harmony in the nature. Four orders of nature; existence as co-existence, harmony at all levels of existence.

**Unit 5** **(8 Hrs)**

**Harmony in the Professional Ethics:** Natural acceptance of human values, Definitiveness of Ethical Human Conduct; Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order; Competence in professional ethics; Case studies; transition from the present state to Universal Human Order: at individual level and societal level.

**Text Books:**

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

**Reference Books:**

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karam chand Gandhi.
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – Pandit Sunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

**Course Outcomes:**

At the end of this course, the students:

**CO1:** Are expected to become more aware of themselves, and their surroundings (family, society, nature)

**CO2**: Would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

**CO3:** Would have better critical ability.

**CO4:** Would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society).

**CO5:** Would be able to apply what they have learnt to their own self in different day-to- day settings in real life, at least a beginning would be made in this direction.

## Sensors and Instrumentation (RAT-001)

**L T P: 3 1 0**

**Course Objectives:**

- To understand the concepts of measurement technology.
- To learn the various sensors used to measure various physical parameters.
- To learn the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development.

**Unit 1**

**Introduction**

Basics of Measurement – Classification of errors – Error analysis – Static and dynamic, characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.

**Unit 2**

**Motion, Proximity and Ranging Sensors**

Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

**Unit 3**

**Force, Magnetic and Heading Sensors**

Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.

**Unit 4**

**Optical, Pressure and Temperature Sensors**

Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors – Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.

**Unit 5**

**Signal Conditioning and DAQ Systems**

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multichannel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

**Text Books**

1. Ernest O Doebelin, "Measurement Systems – Applications and Design", Tata McGraw-Hill, 2009
2. Sawney A K and Puneet Sawney, "A Course in Mechanical Measurements and Instrumentation and Control", 12th edition, Dhanpat Rai & Co, New Delhi, 2013.

**References**

1. C. Sujatha Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001
2. Hans Kurt Tönshoff (Editor), Ichiro, "Sensors in Manufacturing" Volume 1, Wiley-VCH April 2001.
3. John Turner and Martyn Hill, "Instrumentation for Engineers and Scientists", Oxford Science Publications, 1999.
4. Patranabis D, "Sensors and Transducers", 2nd Edition, PHI, New Delhi, 2011.
5. Richard Zurawski, "Industrial Communication Technology Handbook" 2nd edition, CRC Press,2015

**Course Outcomes**

Upon Completion of the course the students will be able to

**CO1:** Be familiar with various calibration techniques and signal types for sensors.

**CO2:** Apply the various sensors in the Automotive and mechatronics applications

**CO3:** Describe the working principle and characteristics of force, magnetic and heading sensors.

**CO4:** Understand the basic principles of various pressure and temperature, smart sensors.

**CO5:** Implement the DAQ systems with different sensors for real time applications.

## Materials Engineering (RAT-002)

**L T P: 3 1 0**

**Course Objectives:**

The course should enable the students to:

- Understand about the different types of materials and their properties.
- Understand the various ferrous material, their production process and properties.
- Study and examine the non-ferrous metals and testing of materials.
- Study the magnetic and electric properties of materials.
- Understand the various Non-Metallic Materials and their uses.

**Particulars**

**Unit 1**

**Crystal Structure**: Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress. Mechanical Property measurement: Mechanical Properties measurement Tensile, compression and torsion tests, strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength.

**Unit 2**

**Static Failure Theories:** Ductile and brittle failure mechanisms, Tresca, Von-mises, Maximum normal stress, Mohr-Coulomb and Modified Mohr-Coulomb; Fracture mechanics: Introduction to Stress-intensity factor approach and Griffith criterion. Fatigue failure: High cycle fatigue, Stress-life approach, SN curve, endurance and fatigue limits, effects of mean stress using the Modified Goodman diagram; Fracture with fatigue, Introduction to non- destructive testing (NDT).

**Unit 3**

**Alloys, Substitutional and Interstitial Solid Solutions- Phase Diagrams:** Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron Iron-carbide phase diagram and microstrctural aspects of ledeburite, austenite, ferrite and cementite, cast iron.

**Unit 4**

**Heat Treatment of Steel:** Annealing, tempering, normalising and spheroidising, isothermal transformation diagrams for Fe-C alloys and microstructure development.

Continuous cooling curves TTT diagram, and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening.

**Unit 5**

Alloying of steel, properties of stainless steel and tool steels, maraging steels- cast irons; grey, white, malleable and spheroidal cast irons- copper and copper alloys; brass, bronze and cupro-nickel; Aluminium and Al-Cu – Mg alloys- Nickel based superalloys and Titanium alloys .

**References**

1. Callister Jr, W. D., & Rethwisch, D. G. (2020). Materials science and engineering: an introduction. Wiley.
2. Budinski, K. G., & Budinski, M. K. (1999). Engineering materials. Pearson Education India.
3. Raghavan, V. (2015). Materials Science and Engineering: A first course. PHI Learning Pvt. Ltd.
4. Jindal, U. C. (2012). Material Science and Metallurgy. Pearson Education India.

**Course Outcomes**

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

**CO1:** Identify crystal structures for various materials and understand the defects in such structures.

**CO2:** Understand how to tailor material properties of ferrous and non-ferrous alloys.

**CO3:** Explain detailed interpretation of equilibrium phase diagrams.

**CO4:** Understand how to quantify mechanical integrity and failure in materials.

**CO5:** Explain the different metals and alloys.

## Fundamentals of Mechatronics (RAT-003)

**L T P: 3 1 0**

**Course Objectives**

The course should enable the students to:

- To focused on the field of Control Systems and Automation.
- To understand the various aspects of control systems, signal conditioning, precision mechanical systems, and electromechanical drives.
- To provide the comprehensive understanding of mechatronics concepts and their applications.

**Unit 1**

**Introduction**: Definition – Trends - Control Methods: Stand alone, PC Based (Real Time Operating Systems, Graphical User Interface, Simulation) - Applications: identification of Sensors and actuators in Washing machine, Automatic Camera, Engine Management, SPM, Robot, CNC, FMS, CIM.

**Unit 2**

**Signal Conditioning**: Introduction – Hardware - Digital I/O, Analog input – ADC, resolution, Filtering Noise using passive components – Registors, capacitors – Amplifying signals using OP amps –Software - Digital Signal Processing – Low pass, high pass, notch filtering

**Unit 3**

**Precision Mechanical Systems**: Modern CNC Machines – Design aspects in machine structures, guideways, feed drives, spindle and spindle bearings, measuring systems, control software and operator interface, gauging and tool monitoring.

**Unit 4**

**Electromechanical Drives:** Relays and Solenoids - Stepper Motors - DC brushed motors – DC brushless motors - DC servo motors - 4-quadrant servo drives, PWM's - Pulse Width Modulation – Variable Frequency Drives, Vector Drives - Drive System load calculation.

**Text Books:**

1. W.Bolton, “Mechatronics”, Pearson education, second edition, fifth Indian Reprint, 2003.
2. Smaili and F. Mrad, "Mechatronics- integrated technologies for intelligent machines", Oxford university press, 2008.

**Reference Books:**

1. R.K Rajput, A textbook of mechatronics, S. Chand & Co, 2007.
2. Michael B. Histand and David G. Alciatore, “Introduction to Mechatronics and Measurement Systems”, McGraw-Hill International Editions, 2000.
3. D. A. Bradley, Dawson D., Buru N.C. and. Loader A.J, “Mechatronics”, Chapman and Hall, 1993.
4. Dan Necsulesu, “Mechatronics”, Pearson Education Asia, 2002 (Indian Reprint).
5. Lawrence J. Kamm, “Understanding Electro – Mechanical Engineering”, An Introduction to Mechatronics, Prentice – Hall of India Pvt., Ltd., 2000.
6. Nitaigour Premchand Mahadik, “Mechatronics”, Tata McGraw-Hill publishing Company Ltd, 2003.

**Course Outcomes**

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

**CO1:** Understand the fundamental principles of control systems, signal conditioning, precision mechanical systems, and electromechanical drives.

**CO2:** Apply appropriate control methods and signal conditioning techniques to various applications, such as washing machines, cameras, robotics, and manufacturing systems.

**CO3:** Analyze and design precision mechanical systems, particularly in the context of modern CNC machines.

**CO4:** Evaluate and select suitable electromechanical drives for different industrial applications.

**CO5:** Demonstrate the ability to calculate and optimize drive system loads for efficient operation.

## Materials Engineering and Testing Lab (RAP-001)

**L T P: 0 0 2**

### Course Objective

The course should enable the students to:

- Acquire the basic knowledge of materials science, so that they would be able to understand and distinguish between varieties of materials based on their structure and properties.
- Gain the knowledge about the properties of materials at higher elevated temperatures.
- Refine properties and grain size of carbon steel and cast iron by heat treatment.
- Understand the Destructive and Non-Destructive methods of testing materials.
- Study and differentiate among microstructures of different engineering materials.

### Particulars

### List of Experiments

Minimum 10 experiments out of the following (or similar experiments).

1. Making a plastic mould for small metallic specimen.
2. Specimen preparation for micro structural examination-cutting, grinding, polishing, etching.
3. Grain size determination of a given specimen.
4. Comparative study of microstructures of different given specimens (mild steel, gray cast iron, brass, copper etc.)
5. Heat treatment experiments such as annealing, normalizing, quenching, case hardening and comparison of hardness before and after.
6. Study of corrosion and its effects.
7. Study of microstructure of welded component and HAZ, Macro and Micro Examination.
8. Suitable experiment on Magnetic/ Electrical/ Electronic materials.
9. To perform Tensile Test on Mild-steel specimen and draw stress strain curve.
10. To perform Izod, Charpy Impact test on standard specimen.
11. To perform Brinell, Rockwell, Vicker Hardness Test on standard specimen.
12. To calculate spring stiffness.
13. To calculate Torsional Rigidity.
14. To calculate Fatigue strength on Fatigue Testing Machine

15. To calculate Modulus of Elasticity by Non Destructive Testing.
16. Detection of cracks by Ultrasonic Testing Machine.
17. Detection of cracks by Dye Penetration Technique.
18. Detection of cracks by Eddy Current Tester.
19. To perform Wear Test

**Reference Books:**

1. Callister Jr, W. D., & Rethwisch, D. G. (2020). Materials science and engineering: an introduction. Wiley
2. Budinski, K. G., & Budinski, M. K. (1999). Engineering materials. Pearson Education India.
3. Raghavan, V. (2015). Materials Science and Engineering: A first course. PHI Learning Pvt. Ltd.
4. Jindal, U. C. (2012). Material Science and Metallurgy. Pearson Education India.
5. Khurmi, R. S., & Khurmi, N. (2019). A textbook of strength of materials. S. Chand Publishing.
6. Bansal, R. K. (2010). A textbook of strength of materials (in SI units). Laxmi Publications.

**Course Outcomes**

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

**CO1**: Correlate the microstructure with the mechanical & physical properties of given set of engineering materials.

**CO2**: Study the microstructure with the mechanical & physical properties of given set of engineering materials.

**CO3**: Perform destructive testing and find out the mechanical properties of given set of engineering materials.

**CO4**: Perform nondestructive testing and to find out any irregularities in the given set of engineering materials.

**CO5**: Conduct tribological experiments and to find out wear rate of given set of engineering materials.

# Mechatronics Lab (RAP-002)

**L T P: 0 0 2**

## Course Objectives

The course should enable the students to:

- To provide students with hands-on experience and practical knowledge in the design, analysis, and implementation of fluid power circuits and control systems.
- Through a series of experiments and projects, students will develop a strong understanding of hydraulic and pneumatic systems, as well as their integration with electrical control systems.
- To equip students with the skills needed to design, simulate, and troubleshoot various fluid power and control circuits, preparing them for real-world applications in engineering and industrial settings.

## Particulars

## LIST OF EXPERIMENTS

1. Design and testing of fluid power circuits to control

(i) Velocity (ii) direction and (iii) force of single and double acting actuators

2. Design of circuits with logic sequence using Electro pneumatic trainer kits.

3. Simulation of basic Hydraulic, Pneumatic and Electric circuits using software

4. Circuits with multiple cylinder sequences in Electro pneumatic using PLC

5. Speed Control of AC & DC drives

6. Servo controller interfacing for DC motor

7. PID controller interfacing

8. Stepper motor interfacing with 8051 Micro controller

(i) Full step resolution (ii) half step resolution

9. Modeling and analysis of basic electrical, hydraulic and pneumatic systems using LAB VIEW

10. Computerized data logging system with control for process variables like pressure flow and temperature.

**Course Outcomes**

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

**CO1:** Understand these experiments and develop practical skills in designing,

**CO2:** Understand these experiments and will analyze, and troubleshoot fluid power and control systems.

**CO3:** Enhance their ability to work with various tools, software, and hardware components commonly used in industrial automation and engineering fields.

**CO4:** Gain experience in teamwork, documentation, and effective communication of findings and solutions.

## Machine Drawing and Solid Modelling Lab (RAP-003)

**L T P: 0 1 2**

**Course Objectives**

The course should enable the students to:

- Apply knowledge of Modeling, Science & Engineering.
- Use engineering graphic skills as a means of communicating technical ideas, information and instructions
- Use of Sectional views, Part sectioning, Assembly drawings and Layouts forms a part of this learning
- Modeled this drawing even in CAD/CAM software by applying the basic knowledge of machine drawing.
- Demonstrate an ability to design and conduct experiments, analyze and interpret data and assembly and disassembly drawings knowledge will be provided.

**Particulars**

**Unit 1**

Introduction to Engineering Drawing, Classification of Engineering Drawings, Machine Drawing and representation of materials, Representation of different types of lines, Representation of geometrical and dimensional tolerance and surface roughness symbols.

**Unit 2**

Conversion of Isometric Views into Orthographic Projection, Symbols for weldments, process flow, electrical and instrumentation Units, IS/ISO codes.

Projections, Sectional views and sectioning of parts and assemblies.

**Unit 3**

Introduction of shapes of rivet heads. Caulking and Fullering pitch, Diagonal pitch, Margin, Back pitch, etc. Types of riveting lap and butt joint, zigzag and chain structure, Boiler joint.

Drawing of Machine Elements and simple parts: Views of any three sets of the following machine elements and parts; Popular forms of Screw threads, bolts, nuts, stud bolts.

Keys, cotter joints and knuckle joint.

Shaft coupling, Hook’s joint, knuckle joint Journal, pivot and collar and foot step bearings.

**Unit 4**

Assembly Drawings: Drawings of assembled views for the part drawings of the following using conventions and easy drawing proportions; (any one)

a) Engine parts – Connecting rod, Piston assembly.

b) Other machine parts - Screws jacks, Machine Vices, Plummer block, Tailstock.

c) Valves: Steam stop valve, spring loaded safety valve, feed check valve and air cock

**Unit 5**

Engineering Graphics Software, Co-ordinate Systems, Drafting and Modelling, Evolution of geometric modeling, Advantages of solid modeling, Definition, Advantages and disadvantages of wireframe models, Solid Representation, Boundary Representation (B-rep), Constructive Solid Geometry (CSG).Solid modeling: Use of modeling software, Part model, Assembly.

**Reference Books:**

1. Bhatt, N. D., & Panchal, V. M. (1991). Machine drawing. Charotar.
2. Dhawan, R. K. (2006). A Textbook of Machine Drawing. S. Chand Publishing.
3. Narayana, K. L. (2009). Machine drawing. New Age International.
4. Kannaiah, P., & Reddy, K. V. (2006). Machine drawing. New Age International.
5. Pohit, G. (2004). Machine Drawing with AutoCAD. Pearson Education India.
6. John, K. C. (2009). Textbook of Machine Drawing. PHI Learning Pvt. Ltd.
7. Gill, P. S. (2013). A Textbook of Machine Drawing. S. K. Kataria & Sons Publishers.

**Course Outcomes**

At the end of the course, student will be able to:

**CO1:** Draft their technical ideas.

**CO2:** Develop their knowledge about the various practices as dimensioning, sectioning and development of views.

**CO3:** Understand the importance of the linking functional and visualization aspects in preparation of the part drawings.

**CO4:** Prepare the part or assembly drawings as per the conventions.

**CO5:** Interpret various machine drawings that will in turn help them to prepare the production drawings.

## Internship I/ Mini Project I (RAP-004)

### Course Objectives

The course should enable the students to:

- Create an Industrial environment and culture within the institution.
- Identify the issues and challenges of an industry.
- Prepare report on the application of emerging technologies in the selected industry.
- Learn and understand the concept of entrepreneurship.
- Inculcate innovative thinking.

### Course Outcomes:

On completion of the course, student will be able to–

**CO1:** Develop his abilities to transmit technical information clearly and test the same by delivery of Seminar based on the Mini Project or Internship.

**CO2:** Understand the importance of document design by compiling Technical Report on the Mini Project or Internship work carried out.

**CO3:** Comment and evaluate other students research questions and internship proposals.

## Python Programming (CST-005)

**L T P: 2 0 0**

### Course Objectives

The course should enable the students to:

- Be introduced with the basic principles and concepts of python programming, and how python programming concepts are useful in problem-solving.
- Write clear and effective python code.
- Perform file operations to read and write data in files.
- Create applications using Python Programming.

### Particulars

**Unit 1** **(8 Hrs)**

**Introduction and Syntax of Python Program:** Features of Python, Interactive, Object-oriented, Interpreted, platform-independent, Python building blocks -Identifiers, Keywords, Indention, Variables, Comments, Python environment setup – Installation and working of IDE, Running Simple Python scripts to display a welcome message, Python variables.

**Python Data Types:** Numbers, String, Tuples, Lists, Dictionary. Declaration and use of datatypes, Built-in Functions.

**Unit 2** **(8 Hrs)**

**Python Operators and Control Flow statements:** Basic Operators: Arithmetic, Comparison/ Relational, Assignment, Logical, Bitwise, Membership, Identity operators, Python Operator Precedence.

**Control Flow:** Conditional Statements (if, if...else, nested if), Looping in python (while loop, for loop, nested loops), loop manipulation using continue, pass, break, else.

**Unit 3** **(8 Hrs)**

**Data Structures in Python: String:** Concept, escape characters, String special operations, String formatting operator, Single quotes, Double quotes, Triple quotes, Raw String, Unicode strings, Built-in String methods.

**Lists:** Defining lists, accessing values in lists, deleting values in lists, updating lists, Basic List Operations, and Built-in List functions.

**Tuples:** Accessing values in Tuples, deleting values in Tuples, and updating Tuples, Basic Tuple operations, and Built-in Tuple functions.

**Sets:** Accessing values in Set, deleting values in Set, and updating Sets, Basic Set operations, Built-in Set functions.

**Dictionaries:** Accessing values in Dictionary, deleting values in Dictionary, and updating Dictionary, Basic Dictionary operations, Built-in Dictionaries functions.

**Unit 4** **(8 Hrs)**

**Python Functions, modules, and Packages:** Use of Python built-in functions (e.g., type/data conversion functions, math functions etc.).

**User-defined functions:** Function definition, Function call, function arguments and parameter passing, Return statement, **Scope of Variables:** Global variable and Local Variable.

**Modules:** Writing modules, importing modules, importing objects from modules, Python built-in modules (e.g., Numeric, mathematical module, Functional Programming Module), Packages.

**Unit 5** **(8 Hrs)**

**File Handling:** Opening files in different modes, accessing file contents using standard library functions, Reading, and writing files, closing a file, Renaming, and deleting files, File related standard functions.

**Text Books:**

1. Charles R. Severance, “Python for Everybody: Exploring Data Using Python 3”, 1st Edition, Create Space Independent Publishing Platform, 2016.
2. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist”, 2nd Edition, Green Tea Press, 2015.
3. Ch Satyanarayana, “Python Programming”, 1st Edition, universities press (India) private limited 2018.

**Reference Books:**

1. Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition, Wiley India Pvt Ltd. ISBN-13: 978-8126556014

2. Mark Lutz, “Programming Python”, 4th Edition, O’Reilly Media, 2011.ISBN-13: 978-9350232873
3. Wesley J Chun, “Core Python Applications Programming”, 3rd edition, Pearson Education India, 2015. ISBN-13: 978-9332555365
4. Roberto Tamassia, Michael H Goldwasser, Michael T Goodrich, “Data Structures and Algorithms in Python”,1st Edition, Wiley India Pvt Ltd, 2016. ISBN-13: 978- 8126562176
5. Reema Thareja, “Python Programming using problem-solving approach”, Oxford university press, 2017.

**Course Outcomes**

On successful completion of the course, the student will be able to:

**CO1:** Develop essential programming skills in computer programming concepts like data types.

**CO2:** Examine Python syntax and semantics and be fluent in the use of Python flow control and functions.

**CO3:** Illustrate the process of structuring the data using lists, tuples, and dictionaries.

**CO4:** Demonstrate using built-in functions and operations to navigate the file system.

**CO5:** Interpret the concepts of modules and user-defined functions in Python.

## Cyber Security (CST-006)

**L T P 2 0 0**

### Course Objectives

The course should enable the students to:

- Familiarize with network security, network security threats, security services, and countermeasures.
- Be aware of computer security and Internet security.
- Study the defensive techniques against these attacks.
- Familiarize with cyber forensics, cybercrimes, and Cyberspace laws.
- Understand ethical laws of computers for different countries, Offences under cyberspace and the Internet in India.

### Particulars

**Unit 1** **(8 Hrs)**

**Introduction to Cyber Security:** Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, the motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Spectrum of attacks, Taxonomy of various attacks, IP spoofing, Methods of defence, Security Models, risk management, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc., CIA Triad

**Unit 2** **(8 Hrs)**

**Cyber Forensics:** Introduction to cyber forensic, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics, Special Techniques for Forensics Auditing.

**Unit 3** **(8 Hrs)**

**Cybercrime (Mobile and Wireless Devices):** Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell

Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Organizational Security Policies and Measures in Mobile Computing Era, Laptops and desktop.

**Unit 4** **(8 Hrs)**

**Cyber Security (Organizational Implications)**: Introduction cost of cybercrimes and IPR issues, web threats for organizations, security and privacy implications, social media marketing: security risks and perils for organizations, social computing, and the associated challenges for organizations.

**Cybercrime and Cyber terrorism:** Introduction, intellectual property in cyberspace, the ethical dimension of cybercrimes, the psychology, mindset and skills of hackers and other cybercriminals.

**Unit 5** **(8 Hrs)**

**Cyberspace and the Law &Miscellaneous provisions of IT Act:** Introduction to Cyber Security Regulations, International Law. The INDIAN Cyberspace, National Cyber Security Policy. Internet Governance – Challenges and Constraints, Computer Criminals, Assets and Threats. Other offences under the Information Technology Act in India, The role of Electronic Evidence and miscellaneous provisions of the IT Act.2008.

**Text Books:**


1. Nina Godbole and SunitBelpure, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley.
2. B. B. Gupta, D. P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335, 2018.


**Reference Books:**


1. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press.
2. Introduction to Cyber Security, Chwan-Hwa(john) Wu,J. David Irwin, CRC Press T&F Group.
3. Debby Russell and Sr. G.T Gangemi, "Computer Security Basics (Paperback)", 2nd Edition, O' Reilly Media, 2006.
4. Wenbo Mao, "Modern Cryptography – Theory and Practice", Pearson Education, New Delhi, 2006.
5. Cyberspace and Cybersecurity, George Kostopoulos, Auerbach Publications, 2012.
6. Cyber Forensics: A Field Manual for Collecting, Examining, and Preserving Evidence of Computer Crimes, Second Edition, Albert Marcella, Jr., Doug Menendez, Auerbach Publications, 2007.

**7.** Cyber Laws and IT Protection, Harish Chander, PHI, 2013.

**Course Outcomes**

On successful completion of the course, the student will be able to:

**CO1:** Understand cyber-attacks and types of cybercrimes, and familiarity with cyber forensics

**CO2:** Realize the importance of cyber security and various forms of cyber-attacks and countermeasures.

**CO3:** Get familiar with obscenity and pornography in cyberspace and understand the violation of the Right to privacy on the Internet.

**CO4:** Appraise cyber laws and how to protect themselves and, ultimately, the entire Internet community from such attacks.

**CO5:** Elucidate the various chapters of the IT Act 2008 power of the Central and State Governments to make rules under IT Act 2008

| B.TECH. (ROBOTICS AND AUTOMATION) SEMESTER-IV | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sl. No.** | **Subject Codes** | **Category** | **Subject** | **Periods** | | | **Evaluation Scheme** | | | | | **Subject Total** | **Credit** |
| | | | | | | | **Sessional Exam** | | | **ESE** | | | |
| | | | | **L** | **T** | **P** | **CT** | **TA** | **Total** | **TE** | **PE** | | |
| 1 | AHT-008 / AHT-007 | HSC | Universal Human Values /Technical Communication | 3 / 2 | 0 / 1 | 0 / 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 2 | RAT-004 | DC | Automatic Control System | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 3 | RAT-005 | DC | Microprocessors and Microcontrollers | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 4 | RAT-006 | DC | Strength of Materials | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 5 | RAT-007 | DC | Manufacturing Science and Technology -I | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 6 | RAP-005 | DLC | Microprocessors and Microcontrollers Lab | 0 | 0 | 2 | | 25 | 25 | | 25 | 50 | 1 |
| 7 | RAP-006 | DLC | Manufacturing Science and Technology -I Lab | 0 | 0 | 2 | | 25 | 25 | | 25 | 50 | 1 |
| 8 | RAP-007 | DLC | Mechanics of Machine Lab | 0 | 0 | 2 | | 25 | 25 | | 25 | 50 | 1 |
| 9 | CST-006/ CST-005 | NC | Python Programming/Cyber Security | 2 | 0 | 0 | 15 | 10 | 25 | 50 | | 75 | |
| 10 | GP-04 | NC | General Proficiency | | | | | | 50 | | | 50 | |
| | | | **Total** | | | | | | | | | **900** | **22** |
| 11 | | | **Open Elective (Optional)** | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | **4** |
| Internship-II/Mini Project-II*<br>To be completed at the end of fourth semester (during Summer Break) & its evaluation/credit to be added in Fifth semester. | | | | | | | | | | | | | |

## Universal Human Values (AHT-008)

**L T P: 3 0 0**

**Course Objectives:**

The course should enable the students for:

- Development of a holistic perspective based on self- exploration about themselves (human being), family, society and nature/existence.
- Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence.
- Strengthening of self-reflection.
- Development of commitment and courage to act.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction - Value Education:** Universal human values; self exploration, natural acceptance an experimental validation; Human aspirations, right understanding, relationship and physical facility, current scenario; Understanding and living in harmony at various levels.

**Unit 2** **(8 Hrs)**

**Harmony in the Human Being:** Understanding human being, needs of self(I) and body; body as an instrument of 'I'; characteristics and activities of 'I' and harmony in 'I'; harmony of I with the Body: Sanyam and Health, Physical needs an prosperity; Programs to ensure Sanyam and Health.

**Unit 3** **(8 Hrs)**

**Harmony in the Family and Society:** Values in human-human relationship; nine universal values in relationships; justice, truth, respect, trust; Difference between intention and competence; Respect and differentiation, Harmony in society: resolution, prosperity, fearlessness and coexistence; Universal harmonious order in society.

**Unit 4** **(8 Hrs)**

**Harmony in the Nature and Existence:** Harmony in the nature. Four orders of nature; existence as co-existence, harmony at all levels of existence.

**Unit 5** **(8 Hrs)**

**Harmony in the Professional Ethics:** Natural acceptance of human values, Definitiveness of Ethical Human Conduct; Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order; Competence in professional ethics; Case studies; transition from the present state to Universal Human Order: at individual level and societal level.

**Text Books:**

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

**Reference Books:**

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karam chand Gandhi.
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

**Course Outcomes:**

At the end of this course, the students:

**CO1:** Are expected to become more aware of themselves, and their surroundings (family, society, nature)

**CO2:** Would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

**CO3:** Would have better critical ability.

**CO4:** Would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society).

**CO5:** Would be able to apply what they have learnt to their own self in different day-to- day settings in real life, at least a beginning would be made in this direction.

## Technical Communication (AHT-007)

**L T P: 2 1 0**

**Course Objectives:**

The course should enable the students to:

- Produce technical documents that use tools commonly employed by engineering and computer science professionals.
- Communicate effectively in a professional context, using appropriate rhetorical approaches for technical documents, adhering to required templates, and complying with constraints on document format.
- Clarify the nuances of phonetics, intonation and pronunciation skills.
- Get familiarized with English vocabulary and language proficiency.

**Particulars**

**Unit 1** **(8 Hrs)**

**Fundamentals of Technical Communication:** Technical Communication: Introduction, Features; Distinction between General and Technical Communication; The flow of Communication: Downward; upward, Lateral or Horizontal; Barriers to Communication, Importance of communication.

**Unit 2** **(8 Hrs)**

**Forms of Technical Communication:** Technical Report: Definition & importance; Thesis/Project writing: structure & importance; synopsis writing: Methods; Technical research Paper writing: Methods & style; Seminar & Conference paper writing; 7 Cs of effective business writing: concreteness, completeness, clarity, conciseness, courtesy, correctness, consideration.

**Unit 3** **(8 Hrs)**

**Technical Presentation: Strategies & Techniques:** Presentation: Forms; interpersonal Communication; Class Room presentation; style; method, Public Speaking: method; Techniques: Clarity of substance; emotion; Humour; Modes of Presentation; Overcoming Stage Fear: Confident speaking; Audience Analysis & retention of audience interest; Methods of Presentation: Interpersonal; Impersonal; Audience Participation: Quizzes & Interjections.

**Unit 4** **(8 Hrs)**

**Technical Communication Skills:** Interview skills; Group Discussion: Objective & Method; Seminar/Conferences Presentation skills: Focus; Content; Style; Argumentation skills: Devices: Analysis; Cohesion & Emphasis; Critical thinking; Nuances, exposition, narration and description.

**Unit 5** **(8 Hrs)**

**Kinesics & Voice Dynamics:** Kinesics: Definitions; importance; Features of Body Language; Voice Modulation: Quality, Pitch; Rhythm; intonation, pronunciation, articulation, vowel and consonants sounds.

**Reference Books**

1. Technical Communication – Principles and Practices by Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2007, New Delhi.
2. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
3. Practical Communication: Process and Practice by L.U.B. Pandey; A.I.T.B.S. Publications India Ltd.; Krishan Nagar, 2014, Delhi.
4. Modern Technical Writing by Sherman, Theodore A (et.al); Apprentice Hall; New Jersey; U.S.
5. A Text Book of Scientific and Technical Writing by S.D. Sharma; Vikas Publication, Delhi.
6. Skills for Effective Business Communication by Michael Murphy, Harward University, U.S.
7. Business Communication for Managers by Payal Mehra, Pearson Publication, Delhi.

**Course Outcomes:**

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

**CO1:** Enabled to understand the nature and objective of Technical Communication relevant for the work place as Engineers.

**CO2:** Able to utilize the technical writing for the purposes of Technical Communication and its exposure in various dimensions.

**CO3:** Able to give imbibe inputs by presentation skills to enhance confidence in face of diverse audience.

**CO4:** Able to create a vast know-how of the application of the learning to promote their technical competence.

**CO5:** Enabling them to evaluate their efficacy as fluent & efficient communicators by learning the voice-dynamics.

## Automatic Control Systems (RAT-004)

**L T P: 3 1 0**

**Course Objectives**

- To study the basics of control system and its response. Stability of mechanical and electrical systems. Use of MATLAB to design a stable control system.
- To introduce the elements of control system and their modeling using various Techniques.
- To introduce methods for analyzing the time response.
- To impart knowledge about the frequency response and the stability of systems
- To introduce the state variable analysis method

**Particulars**

**Unit 1**

**Introduction:** Open loop and closed loop systems - Examples - Elements of closed loop systems - Transfer function - Modeling of physical systems – Mechanical, Thermal, Hydraulic systems and Electric Networks - Transfer function of DC generator, DC servomotor, AC servomotor, Potentiometer, Synchros, Tacho- generator, Stepper motor - Block diagram - reduction techniques, Signal flow graph – Mason‟ gain formula. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

**Unit 2**

**Time Domain Analysis:** Standard Test signals – Time response of second order system - Time domain specifications – Types of systems - Steady state error constants - Introduction to P, PI and PID modes of feedback control. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

**Unit 3**

**Frequency Domain Analysis:** Frequency domain specifications - Time and frequency response correlation – Polar plot – Bode plot – All pass minimum phase and non-minimum phase systems. (Related Tutorials Using MATLAB/Simulink – Toolboxes & Functions)

**Unit 4**

**System Stability:** Characteristic equation - Routh Hurwitz criterion of stability - Absolute and Relative stability – Nyquist stability - Nyquist stability criterion - Assessment of relative stability – Gain and Phase Margin. (Related Tutorials Using MATLAB/ Simulink – Tool boxes & Functions)

**Unit 5**

**Root Locus Method:** Root locus concepts - Construction of root loci – Root contours. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions) STATE SPACE ANALYSIS: Limitations of conventional controltheory - Concepts of state, state variables and state model – state model for linear time invariant systems - Introduction to state space representation using physical - Phase and canonical variables. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

**Text Books:**

1. Nagrath I J, and Gopal, M, 'Control Systems Engineering" Prentice Hall of India, New Delhi, 2008.
2. Richard C Dorf and Robert H Bishop, "Modern Control Systems.", Addison-Wesley -2007

**References:**

1. Ogata K, "Modern Control Engineering", Pearson Education, New Delhi, 2006.
2. Kuo B C, "Automatic Control Systems", Prentice-Hall of India Pvt. Ltd, New Delhi, 2004.
3. Norman C. Nise S, “Control system Engineering“, John Wiley & Sons, Singapore, 2004.

**Course Outcomes**

At the end of the course, student will be able to:

**CO1:** To understand the basic of the control system

**CO2:** Ability to know about the time and frequency domain analysis

**CO3:** To know about the different stability of the systems

**CO4:** To expose students to the state space representation and its analysis.

**CO5:** To introduce non-linear systems and their control and to impart knowledge on advancedcontrol techniques.

## Microprocessors and Microcontrollers (RAT-005)

**L T P: 3 1 0**

**Course Objectives**

- Study the Architecture of 8085 microprocessor.
- Study the Architecture of 8086 microprocessor.
- Learn the design aspects of I/O and Memory Interfacing circuits.
- Study about communication and bus interfacing.
- Study the Architecture of 8051 microcontroller.

**Particulars**

**Unit 1**

**8086 Microprocessor:** Architecture – Pin description – Operating modes – Registers – Interrupts – Bus cycle – Addressing modes – Typical configuration of 8086 system – Overview of Instruction set.

**Unit 2**

**80286 Microprocessor:** Functional block diagram - Modes of operation – Real and protected mode – Memory management and protection features.

**Unit 3**

**80386, 80486 Processors:** 80386: Functional block diagram - Programming model - Addressing modes and instruction set overview – Address translation - Modes of operation - 80486 processor - Functional block diagram- Comparison of 80386 and 80486 processors.

**Unit 4**

**Pentium Microprocessor:** Introduction – Architecture – Special Pentium registers – Memory management.

**Unit 5**

**Pic Microcontroller:** Architecture – Memory structure – Register File – Addressing modes – Interrupts – Timers: Modes of operation PIC PERIPHERAL FUNCTIONS AND SPECIAL FEATURES: PWM output – Analog to Digital converter – UART – Watchdog timer – RESET Alternatives – Power Down mode – I2C Bus operation.

**Text books:**

1. Barry B Brey, "The Intel Microprocessor 8086/8088, 80186/80188, 80286, 80386, 80486 Pentium and Pentium processor, Pentium II,III,4, Prentice Hall of India, New Delhi, 2005.

2. Douglas V Hall, "Microprocessors and Interfacing: Programming and Hardware", McGraw Hill,

New Delhi, 2005.

3. John B Peatman, “Design with PIC Microcontroller, McGraw Hill, Singapore, 1st Reprint, 2001

**References:**

1. Mohammed Rafiquzzaman, "Microprocessors and microcomputer-based system design", CRC Press, 2005.

2. Walter A Triebel, Avtar Singh” The 8088 and 8086 microprocessors Programming Interfacing software, Hardware and Applications”, Pearson Education , 2009

3. Myke Pred ko, “Programming and Customising the PIC Microcontroller, “McGraw Hill, USA, 1998

**Course Outcomes**

At the end of the course, student will be able to:

**CO1:** Design and implement programs on 8085 microprocessor.

**CO2:** Design and implement programs on 8086 microprocessor.

**CO3:** Design I/O circuits.

**CO4:** Design Memory Interfacing circuits.

**CO5:** Design and implement 8051 microcontroller-based systems.

## Strength of Material (RAT-006)

**L T P: 3 1 0**

**Course Objectives**

The course should enable the students to:

- Confidently tackle equilibrium equations, moments and inertia problems.
- To solve real field problems through evaluating the relationship between stress and strain.
- To understand the shear force and bending moment diagrams of symmetrical beams.
- To determine deflection, bending and shear stresses developed in beams of various sections
- To understand and apply the concept of stress and strain to analyze and design structural members and machine parts under axial load, shear load, bending moment and torsion

**Particulars**

**Unit 1**

**Simple Stress and Strain:** Introduction, Normal and shear stresses, Hooke's law, Stress strain diagrams for ductile and brittle materials, Elastic constants- Relationship between elastic constant one dimensional loading of members of varying cross-section, Strain energy, Thermal stresses.

Compound stress and strain: Introduction, State of plane stress, Principal stress and strain, Mohr's circle for stress, Moment of Inertia.

**Unit 2**

**Beams:** Definition and types of beams (cantilever, simply supported, overhanging, fixed, continuous), Types of end supports (simply support, hinged, roller, fixed), Classification of loads (point load, inclined point load, uniformly distributed load, uniformly varying load) Reactions of a simply supported and overhanging beam by analytical method.

**Pure Bending of Beams:** Introduction, Simple bending theory, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads.

**Unit 3**

**Stresses in Beams:** Bending moment (BM) and shear force (SF) diagrams. BM and SF diagrams for cantilevers simply supported and fixed beams with or without overhangs. Calculation of maximum BM and SF and the point

of contra-flexure under concentrated loads, uniformly distributed loads over the whole span or part of the span. Deflection of beams: Equation of elastic curve, cantilever and simply supported beams. Double integration method, Moment area method, Macaulay's method, Maxwell's reciprocal theorems.

**Torsion:** Introduction, Derivation of torsion equation and its assumptions. Torsional rigidity. Torsion stresses and deformation in circular and hollow shafts, stepped shafts, combined torsion and bending of circular shafts, Torsion of non- circular shaft.

**Unit 4**

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

**Columns and Struts:** Combined bending and direct stress, middle third and middle quarter rules. Struts with different end conditions. Euler's theory and experimental results, Rankine Jordan Formulae, Examples of columns in mechanical equipment's and machines. Columns and Struts: Combined bending and direct stress, middle third and middle quarter rules. Struts with different end conditions. Euler's theory and experimental results, Rankine Jordan Formulae, Examples of columns in mechanical equipment's and machines.

**Unit 5**

**Introduction to Stress and Strain in 3D**

Introduction to stress in 3D, Stress components on an arbitrary plane, Differential equations of equilibrium, Boundary conditions, Strains: Concept of strain.

**Relationship between elastic constants for different materials**

Stress-strain relations for linearly elastic solid, Generalized Hooke's law, Stress-strain relations for isotropic, orthotropic and anisotropic materials.

**Reference Books:**

1. Strength of Materials by R.Subramaniam, Oxford University Press, New Delhi, 2007.
2. Strength of Materials by B.C. Punamia, Laxmi Publications, 2015
3. Gere J. M., Timoshenko S.P., Mechanics of materials, CBS Publication, 2nd edition, ISBN- 8123908946.
4. Popov Eger P.,"Engg. Mechanics of solids", Prentice Hall, New Delhi, 2nd edition, ISBN- 0135713560.
5. Hibbeler R.C.,"Mechanics of Materials", Prentice Hall, New Delhi, 9th edition, ISBN- 0133254429.
6. Fenner, Roger.T, "Mechanics of Solids", U.K. B.C. Publication, New Delhi.
7. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata McGraw-Hill Publishing Co. Ltd., New Delhi 2005

**Course Outcomes**

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

**CO1:** 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.

**CO2:** Analyze determinate beams and trusses to determine shear forces, bending moments and axial forces.

**CO3:** Gain sufficient knowledge in designing shafts to transmit required power and also spring for its maximum energy storage capacities.

**CO4:** Identify modes of failure in components.

**CO5:** Identify, formulate and solve engineering problems.

## Manufacturing Science and Technology – I (RAT-007)

**L T P: 3 1 0**

**Course Objective**

The course should enable the students to:

- Understand the different metal casting processes, different metal forming and sheet metal operations along with the force calculations.
- Study the basic manufacturing processes and tools.
- Understand different conventional machining processes.
- Understand different nonconventional process.
- Emphasize the importance of manufacturing.

**Particulars**

**Unit 1**

**Introduction:** Importance of manufacturing, Economic & technological considerations in manufacturing. Classification of manufacturing processes, Materials & manufacturing processes for common items.

**Casting:** Basic principle & survey of casting processes. Types of patterns and allowances. Types and properties of moulding sand. Elements of mould and design considerations, Gating, Riser, Runners, Core. Solidification of casting,. Sand casting, defects & remedies and inspection. Die Casting, Centrifugal casting. Investment casting, $CO_2$ casting and Stir casting etc.

**Unit 2**

**Metal Forming Processes:** Elastic & plastic deformation, yield criteria, Hot working vs. cold working. Analysis (equilibrium equation method) of forging process for load estimation with sliding friction sticking friction and mixed condition for slab and disc. Work required for forging, Hand, Power, Drop Forging. Analysis of Wire/strip drawing and maximum- education, Tube drawing, Extrusion and its application.

**Unit 3**

**Rolling:** Condition for Rolling force and power in rolling, Rolling mills & rolled-sections. Design, lubrication and defects in metal forming processes.

**Sheet Metal working:** Presses and their classification, Die & punch assembly and press work methods and processes. Cutting/Punching mechanism. Blanking vs. Piercing. Compound vs Progressive die. Flat-face vs. Inclined-face punch and Load (capacity) needed. Analysis of forming process like cup/deep drawing. Bending & spring-back.

**Unit 4**

**Unconventional Metal forming processes:** Unconventional metal forming processes such as explosive forming, electromagnetic, electro-hydraulic forming.

**Powder Metallurgy:** Powder metallurgy manufacturing process. The need, process, advantage and applications.

**Manufacturing of Plastic components:** Injection moulding, Extrusion of plastic section, Welding of plastics.

**Unit 5**

**Jigs & Fixtures:** Locating & Clamping devices & principles, Jigs and Fixtures and its applications.

**Metrology:** Dimensions, forms and surface measurements, Limits, fits and tolerances, measurement of geometric forms like straightness, flatness and roundness; linear and angular measurement devices and systems; comparators; gauge design; interferometry; Metrology in tool wear and part quality including surface integrity, alignment and testing methods.

**Reference Books:**

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)- Pearson India, 2014.
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems.
3. Degarmo, Black &Kohser, Materials and Processes in Manufacturing.
4. Ghosh and A. K. Malik (2010) Manufacturing Science, East West Press Private Limited New Delhi.
5. PN Rao, “Manufacturing Technology”, Tata McGraw Hill, 2017.

**Course Outcomes**

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

**CO1:** Explain the different metal casting processes.

**CO2:** Explain the different metal forming and sheet metal operations along with the force calculations.

**CO3:** Explain the theory of rolling and sheet metal work.

**CO4:** Explain the different unconventional metal forming processes, powder metallurgy and manufacturing of plastic component.

**CO5:** Explain the jigs and fixture use and metrology.

## Microprocessors and Microcontrollers Lab (RAP-005)

**L T P: 0 0 2**

**Course Objective**

The course should enable the students to:

- To provide students with practical experience in designing, implementing, and testing various electronic projects using microcontrollers, specifically focusing on the 8051 microcontroller.
- To gain a solid foundation in microcontroller interfacing, programming, and applications.
- To develop students' skills in project development, troubleshooting, and understanding the integration of microcontroller-based systems in real-world scenarios.

**Particulars**

1. Controlling Light using Touch Sensor and 8051 Microcontroller.
2. 8051 Microcontroller based Frequency Counter.
3. Android Controlled Robot using 8051 Microcontroller.
4. RFID Interfacing with 8051 Microcontroller.
5. Digital Thermometer using LM35 and Microcontroller.
6. Displaying an Image on Graphical LCD using 8051 Microcontroller.
7. Digital Clock using 8051 Microcontroller.
8. Interfacing ADC0808 with 8051 Microcontroller.
9. Digital Code Lock using 8051 Microcontroller.
10. Bluetooth Controlled Home Automation System using 8051.

**Course Outcomes**

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

**CO1:** Gain hands-on experience in working with microcontrollers, sensors, actuators, and communication interfaces.

**CO2:** Program microcontrollers, interface them with various components, and develop functional applications.

**CO3:** Enhance problem-solving abilities, project management skills, and teamwork through collaborative project development.

**CO4:** Equip with practical skills applicable in fields such as embedded systems, robotics, automation, and IoT-based applications.

## Manufacturing Science and Technology – I Lab (RAP-006)

**L T P: 0 0 2**

**Course Objective**

The course should enable the students to:

- To provide practical experience in various casting and metal forming processes with different materials.
- Learn the use of jigs and fixtures.
- To inculcate the knowledge of experiments on metrology
- To impart the basic knowledge of powder metallurgy.

**Particulars**

**List of Experiments:**

Minimum 10 experiments out of following:

1. Design of pattern for a desired casting (containing hole)
2. Pattern making
3. Making a mould (with core) and casting.
4. Sand testing (at least one such as grain fineness number determination)
5. Forging: hand forging processes.
6. Forging: power hammer study & operation
7. Bending & spring back.
8. Powder metallurgy process related experiment.
9. Jigs & Fixture experiment.
10. Study of Linear Measuring Instruments.
11. Measurement of Taper Angle Using Slips, Rollers & Sine bar
12. Tool Makers Microscope.
13. Measurement of Surface Finish.
14. Machine Tool Alignment Tests.

**Reference Books:**

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)- Pearson India, 2014.
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems.

3. Degarmo, Black & Kohser, Materials and Processes in Manufacturing.
4. Ghosh and A. K. Malik (2010) Manufacturing Science, East West Press Private Limited New Delhi.
5. PN Rao, “Manufacturing Technology”, Tata McGraw Hill, 2017.

**Course Outcomes**

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

**CO1**: Perform the different experiments on metal casting.

**CO2**: Perform the different experiments on metal forming.

**CO3**: Perform the different experiments on jigs and fixture.

**CO4**: Perform the different experiments on powder metallurgy.

**CO5**: Perform the different experiments on metrology.

## Mechanics of Machine Lab (RAP-007)

**L T P: 0 0 2**

### Course Objectives

The course should enable the student to:

- Provide basic concepts on mechanisms, machines.
- Analyze the velocities of various links in mechanisms using models.
- Introduce with the CAMs and their design.
- Introduce with various model of gears, classification and their types.

**Particulars**

### List of Experiments (Minimum 10)

1. To study various types of Links, Pairs, Chain and Mechanism

2. To study inversion of Four Bar Mechanism, Single Slider Crank Chain Mechanism and Double Slider Crank Chain Mechanism.

3. To study velocity diagram for Slider Crank Mechanism.

4. To study various kinds of belts drives.

5. To study and find coefficient of friction between belt and pulley.

6. To study various types of Cam and Follower arrangement.

7. To plot follower displacement vs cam rotation graph for various cam follower arrangement.

8. To study the working of Screw Jack and determine its efficiency.

9. To study Different types of Gears.

10. To study Different types of Gear Trains.

11. Study of Ackerman's Steering Gear Mechanism

**Course Outcomes**

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

**CO1:** Understand principle and functioning of mechanism such as slider crank, four bar chain, Ackerman's steering.

**CO2:** Gain knowledge about the kinds of belt drives and calculate the coefficient of friction between belt and pulley.

**CO3:** Plot cam profiles for different arrangements.

**CO4:** Understand functioning of different gears.

**CO5:** Determine screw jack efficiency.

## Python Programming (CST-006)

**L T P: 2 0 0**

### Course Objectives

The course should enable the students to:

- Be introduced with the basic principles and concepts of python programming, and how python programming concepts are useful in problem-solving.
- Write clear and effective python code.
- Perform file operations to read and write data in files.
- Create applications using Python Programming.

### Particulars

**Unit 1** **(8 Hrs)**

**Introduction and Syntax of Python Program:** Features of Python, Interactive, Object-oriented, Interpreted, platform-independent, Python building blocks -Identifiers, Keywords, Indention, Variables, Comments, Python environment setup – Installation and working of IDE, Running Simple Python scripts to display a welcome message, Python variables.

**Python Data Types:** Numbers, String, Tuples, Lists, Dictionary. Declaration and use of datatypes, Built-in functions.

**Unit 2** **(8 Hrs)**

**Python Operators and Control Flow statements:** Basic Operators: Arithmetic, Comparison/ Relational, Assignment, Logical, Bitwise, Membership, Identity operators, Python Operator Precedence.

**Control Flow:** Conditional Statements (if, if...else, nested if), Looping in python (while loop, for loop, nested loops), loop manipulation using continue, pass, break, else.

**Unit 3** **(8 Hrs)**

**Data Structures in Python: String:** Concept, escape characters, String special operations, String formatting operator, Single quotes, Double quotes, Triple quotes, Raw String, Unicode strings, Built-in String methods.

**Lists:** Defining lists, accessing values in lists, deleting values in lists, updating lists, Basic List Operations, and Built-in List functions.

**Tuples:** Accessing values in Tuples, deleting values in Tuples, and updating Tuples, Basic Tuple operations, and Built-in Tuple functions.

**Sets:** Accessing values in Set, deleting values in Set, and updating Sets, Basic Set operations, Built-in Set functions.

**Dictionaries:** Accessing values in Dictionary, deleting values in Dictionary, and updating Dictionary, Basic Dictionary operations, Built-in Dictionaries functions.

**Unit 4** **(8 Hrs)**

**Python Functions, modules, and Packages:** Use of Python built-in functions (e.g., type/data conversion functions, math functions etc.).

**User-defined functions:** Function definition, Function call, function arguments and parameter passing, Return statement, **Scope of Variables:** Global variable and Local Variable.

**Modules:** Writing modules, importing modules, importing objects from modules, Python built-in modules (e.g., Numeric, mathematical module, Functional Programming Module), Packages.

**Unit 5** **(8 Hrs)**

**File Handling:** Opening files in different modes, accessing file contents using standard library functions, Reading, and writing files, closing a file, Renaming, and deleting files, File related standard functions.

**Text Books:**

1. Charles R. Severance, “Python for Everybody: Exploring Data Using Python 3”, 1st Edition, Create Space Independent Publishing Platform, 2016.
2. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist”, 2nd Edition, Green Tea Press, 2015.
3. Ch Satyanarayana, “Python Programming”, 1st Edition, universities press (India) private limited 2018.

**Reference Books:**

1. Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition, Wiley India Pvt Ltd. ISBN-13: 978-8126556014

2. Mark Lutz, “Programming Python”, 4th Edition, O’Reilly Media, 2011.ISBN-13: 978-9350232873
3. Wesley J Chun, “Core Python Applications Programming”, 3rd edition, Pearson Education India, 2015. ISBN-13: 978-9332555365
4. Roberto Tamassia, Michael H Goldwasser, Michael T Goodrich, “Data Structures and Algorithms in Python”,1st Edition, Wiley India Pvt Ltd, 2016. ISBN-13: 978- 8126562176
5. Reema Thareja, “Python Programming using problem-solving approach”, Oxford university press, 2017.

**Course Outcomes**

On successful completion of the course, the student will be able to:

**CO1:** Develop essential programming skills in computer programming concepts like data types.

**CO2:** Examine Python syntax and semantics and be fluent in the use of Python flow control and functions.

**CO3:** Illustrate the process of structuring the data using lists, tuples, and dictionaries.

**CO4:** Demonstrate using built-in functions and operations to navigate the file system.

**CO5:** Interpret the concepts of modules and user-defined functions in Python.

## Cyber Security (CST-005)

**L T P: 2 0 0**

### Course Objectives

The course should enable the students to:

- Familiarize with network security, network security threats, security services, and countermeasures.
- Be aware of computer security and Internet security.
- Study the defensive techniques against these attacks.
- Familiarize with cyber forensics, cybercrimes, and Cyberspace laws.
- Understand ethical laws of computers for different countries, Offences under cyberspace and the Internet in India.

### Particulars

**Unit 1** **(8 Hrs)**

**Introduction to Cyber Security:** Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, the motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Spectrum of attacks, Taxonomy of various attacks, IP spoofing, Methods of defence, Security Models, risk management, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc., CIA Triad

**Unit 2** **(8 Hrs)**

**Cyber Forensics:** Introduction to cyber forensic, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics, Special Techniques for Forensics Auditing.

**Unit 3** **(8 Hrs)**

**Cybercrime (Mobile and Wireless Devices):** Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell

Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Organizational Security Policies and Measures in Mobile Computing Era, Laptops and desktop.

**Unit 4** **(8 Hrs)**

**Cyber Security (Organizational Implications)**: Introduction cost of cybercrimes and IPR issues, web threats for organizations, security and privacy implications, social media marketing: security risks and perils for organizations, social computing, and the associated challenges for organizations.

**Cybercrime and Cyber terrorism:** Introduction, intellectual property in cyberspace, the ethical dimension of cybercrimes, the psychology, mindset and skills of hackers and other cybercriminals.

**Unit 5** **(8 Hrs)**

**Cyberspace and the Law &Miscellaneous provisions of IT Act:** Introduction to Cyber Security Regulations, International Law. The INDIAN Cyberspace, National Cyber Security Policy. Internet Governance – Challenges and Constraints, Computer Criminals, Assets and Threats. Other offences under the Information Technology Act in India, The role of Electronic Evidence and miscellaneous provisions of the IT Act.2008.

**Text Books:**


1. Nina Godbole and Sunit Belpure, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley.
2. B. B. Gupta, D. P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335, 2018.


**Reference Books:**


1. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press.
2. Introduction to Cyber Security, Chwan-Hwa(john) Wu,J. David Irwin, CRC Press T&F Group.
3. Debby Russell and Sr. G.T Gangemi, "Computer Security Basics (Paperback)", 2nd Edition, O' Reilly Media, 2006.
4. Wenbo Mao, "Modern Cryptography – Theory and Practice", Pearson Education, New Delhi, 2006.
5. Cyberspace and Cyber security, George Kostopoulos, Auerbach Publications, 2012.
6. Cyber Forensics: A Field Manual for Collecting, Examining, and Preserving Evidence of Computer Crimes, Second Edition, Albert Marcella, Jr., Doug Menendez, Auerbach Publications, 2007.

**7.** Cyber Laws and IT Protection, Harish Chander, PHI, 2013.

**Course Outcomes**

On successful completion of the course, the student will be able to:

**CO1:** Understand cyber-attacks and types of cybercrimes, and familiarity with cyber forensics

**CO2:** Realize the importance of cyber security and various forms of cyber-attacks and countermeasures.

**CO3:** Get familiar with obscenity and pornography in cyberspace and understand the violation of the Right to privacy on the Internet.

**CO4:** Appraise cyber laws and how to protect themselves and, ultimately, the entire Internet community from such attacks.

**CO5:** Elucidate the various chapters of the IT Act 2008 power of the Central and State Governments to make rules under IT Act 2008

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY

*(Formerly Uttarakhand Technical University, Dehradun Established by Uttarakhand State Govt. wide Act no. 415 of 2005)*
*Suddhowala, PO-Chandanwadi, Premnagar, Dehradun, Uttarakhand (Website- www.uktech.ac.in)*

# SYLLABUS

**For**

## B.TECH

## (Robotics & Automation Engineering)

## 3rd Year

Effective from – Session 2024-25

**B.TECH. (ROBOTICS AND AUTOMATION) SEMESTER-V**

| Sl. No. | Subject Codes | Category | Subject | Periods | | | Evaluation Scheme | | | | | Subject Total | Credit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Sessional Exam | | | ESE | | | |
| | | | | L | T | P | CT | TA | Total | TE | PE | | |
| 1 | RAT-008 | DC | Pneumatics & Hydraulic Systems | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 2 | RAT-009 | DC | CNC Machine and Metrology | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 3 | RAT-010 | DC | Modern Automated and Intelligent Electric Vehicles | 3 | 0 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 4 | RAT-XXX | DE | Departmental Elective - 1 | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 5 | RAT-XXX | DE | Departmental Elective - 2 | 3 | 0 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 6 | RAP-008 | DC | Modern Automated and Intelligent Electric Vehicles Lab | 0 | 0 | 2 | | 25 | 25 | | 25 | 50 | 1 |
| 7 | RAP-009 | DLC | CNC Machine and Metrology Lab | 0 | 0 | 2 | | 25 | 25 | | 25 | 50 | 1 |
| 8 | RAP-010 | DLC | Pneumatics & Hydraulic Systems Lab | 0 | 0 | 2 | | 25 | 25 | | 25 | 50 | 1 |
| 9 | RAP-011 | DLC | Mini Project-II or Internship-II* | 0 | 0 | 2 | | | 50 | | | 50 | 1 |
| 10 | AHT-009/ AHT-010 | NC | Constitution of India / Essence of Indian Traditional Knowledge | 2 | 0 | 0 | 15 | 10 | 25 | 50 | | 75 | |
| 11 | GP-05 | NC | General Proficiency | | | | | | 50 | | | 50 | |
| | | | **Total** | **17** | **3** | **8** | | | | | | **950** | **22** |
| 12 | | | Open Elective (Optional) | 3 | 1 | 0 | 30 | 20 | 50 | 50 | | 150 | 4 |

*The Mini Project-II or Internship-II (4-6 weeks) conducted during summer break after IV semester and will be assessed during V semester

| **Departmental Elective - 1** | | **Departmental Elective - 2** | |
|---|---|---|---|
| RAT-011 | Implementation of Quality Management system | RAT-016 | Design of Machine elements and Transmission system |
| RAT-012 | Microcontrollers and Embedded system | RAT-017 | Optimization Techniques in Engineering |
| RAT-013 | Advanced Strength of Material | RAT-018 | Finite Element Method |
| RAT-014 | Introduction of Data Science | RAT-019 | Computer Architecture |
| RAT-015 | Advanced Materials for Robotics | RAT-020 | Advanced Welding Technology |

## Pneumatics and Hydraulics Systems (RAT-008)

**LTP: 3 1 0**

**Course Objective**:

- To provide student with knowledge on the application of fluid power in process, construction and manufacturing Industries.
- To provide students with an understanding of the fluids and components utilized in modern industrial fluid power system.
- To develop a measurable degree of competence in the design, construction and operation of fluid power circuits.

**Unit 1** **(12 Hrs)**

**Fluid Power Principles and Hydraulic Pumps**

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power: Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps – Problems.

**Unit 2** **(10 Hrs)**

**Hydraulic Actuators and Control Components**

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components: Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories: Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems.

**Unit 3** **(10 Hrs)**

**Hydraulic Circuits and Systems**

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double- Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

**Unit 4**

**Pneumatic and Electro Pneumatic Systems**

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits.

**Unit 5**

**Trouble Shooting and Applications**

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low-cost Automation – Hydraulic and Pneumatic power packs.

**Text Books:**

1. Anthony Esposito, “Fluid Power with Applications”, Pearson Education 2005.

2. Majumdar S.R., “Oil Hydraulics Systems- Principles and Maintenance”, Tata McGraw-Hill, 2001.

**References:**

1. Anthony Lal, “Oil hydraulics in the service of industry”, Allied publishers, 1982.

2. Dudelyt, A. Pease and John T. Pippenger, “Basic Fluid Power”, Prentice Hall, 1987.

3. Majumdar S.R., “Pneumatic systems – Principles and maintenance”, Tata McGraw Hill, 1995

4. Michael J, Prinches and Ashby J. G, “Power Hydraulics”, Prentice Hall, 1989.

5. Shanmugasundaram.K, “Hydraulic and Pneumatic controls”, Chand & Co, 2006 Dynamics of Machines & Vibrations

**Course Outcomes**

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

**CO1:** Explain the Fluid power and operation of different types of pumps.

**CO2:** Summarize the features and functions of Hydraulic motors, actuators and Flow control valves

**CO3:** Explain the different types of Hydraulic circuits and systems

**CO4:** Explain the working of different pneumatic circuits and systems

**CO5:** Summarize the various trouble shooting methods and applications of hydraulic and pneumatic systems.

# CNC Machine and Metrology (RAT-009)

**L T P: 3 1 0**

**Course Objective**s

- Understand evolution and principle of CNC machine tools
- Write simple programs for CNC turning and machining centres
- Generate CNC programs for popular CNC controllers
- Describe about linear and angular measurements in metrology
- Study about the advancement in metrology

## Particulars

**Unit 1** **(8 Hrs)**

**Introduction to CNC Machine Tools:** Evolution of CNC Technology, principles, features, advantages, applications, CNC and DNC concept, classification of CNC Machines – turning centre, machining centre, grinding machine, EDM, types of control systems, CNC controllers, characteristics, interpolators– Computer Aided Inspection, CNC Machine building, structural details, configuration and design, guide ways – Friction, Anti friction and other types of guide ways.

**Unit 2** **(8 Hrs)**

**Drives and Work Holding Devices:** Spindle drives – DC shunt motor, 3 phase AC induction motor, feed drives –stepper motor, servo principle, DC and AC servomotors, Axis measuring system – synchro, synchro-resolver, gratings, moiré fringe gratings, encoders, inductosysn, laser interferometer, work holding devices for rotating and fixed work parts, economics of CNC, maintenance of CNC machines.

**Unit 3** **(8 Hrs)**

**CNC Programming:** Coordinate system, structure of a part program, G & M Codes, tool length compensation, cutter radius and tool nose radius compensation, do loops, subroutines, canned cycles, mirror image, parametric programming, machining cycles, programming for machining centre and turning centre for well-known controllers such as Fanuc, Heidenhain, Sinumerik etc., generation of CNC codes from CAM packages

**Unit 4** **(8 Hrs)**

**Linear and Angular Measurements:** Linear Measuring Instruments – Evolution – Types – Classification – Limit gauges – gauge design – terminology – procedure – concepts of interchange ability and selective assembly – Angular measuring instruments – Types – Bevel protractor clinometers angle gauges, spirit levels sine bar – Angle alignment telescope – Autocollimator – Applications.

**Unit 5**

**Advances in Metrology:** Basic concept of lasers Advantages of lasers – laser Interferometers – types – DC and AC Lasers interferometer – Applications – Straightness – Alignment. Basic concept of CMM – Types of CMM– Constructional features – Probes – Accessories – Software – Applications – Basic concepts of Machine Vision System – Element – Applications.

**Text Books:**

1. "Mechatronics", HMT, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005.

2. Warren S.Seamers, "Computer Numeric Control", Fourth Edition, Thomson Delmar, 2002.

3. Jain R.K. "Engineering Metrology", Khanna Publishers, 2005.

4. Gupta. I.C., "Engineering Metrology", Dhanpatrai Publications, 2005.

**References:**

1. Charles Reginald Shotbolt, "Metrology for Engineers", 5th edition, Cengage Learning EMEA, 1990.

2. Backwith, Marangoni, Lienhard, "Mechanical Measurements", Pearson Education, 2006.

3.Peter Smid, "CNC Programming Hand book", Industrial Press Inc., 2000

4. Berry Leathan – Jones, "Introduction to Computer Numerical Control", Pitman, London, 1987.

5. Radhakrishnan P "Computer Numerical Control Machines", New Central Book Agency, 2002.

**Course Outcomes:**

Upon completion of this course the students can able to understand

**CO1:** Ability to know about the basic in CNC machineries

**CO2:** Evolution and principle of CNC machine tools and different measurement technologies

**CO3:** Able to write simple programs for CNC machinery

**CO4:** To impart knowledge about linear and angular measurements in metrology

**CO5:** Ability to know about the advancement in metrology.

## Modern Automated and Intelligent Electric Vehicles (RAT-010)

**L T P: 3 1 0**

**Course Objective**

The objective of this course is to provide students with a comprehensive understanding of electric and hybrid electric vehicles, automotive electronics, connected and autonomous vehicle technology, sensor systems, and advanced driver assistance systems. Through theoretical concepts and practical applications, students will gain insights into the evolving landscape of automotive technology, preparing them to contribute to the development and implementation of innovative automotive solutions.

**Unit 1** **(8 Hrs)**

**Introduction:** Introduction to electric and hybrid electric vehicles, History of hybrid and electric vehicles, Social and environmental importance of electric and hybrid electric vehicles

**Unit 2** **(8 Hrs)**

Introduction to Automated, Connected, and Intelligent Vehicles, Introduction to the Concept of Automotive Electronics, Automotive Electronics Overview, History & Evolution, Infotainment, Body, Chassis, and Power train Electronics, Advanced Driver Assistance Electronic Systems.

**Unit 3** **(10 Hrs)**

Connected and Autonomous Vehicle Technology, Basic Control System Theory applied to Automobiles Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles, Role of Surroundings Sensing Systems and Autonomy, Role of Wireless Data Networks and Autonomy.

**Unit 4** **(10 Hrs)**

Sensor Technology for Advanced Driver Assistance Systems, Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology Other Sensors, Use of Sensor Data Fusion, Integration of Sensor Data to On-Board Control Systems Advanced Driver Assistance System Technology, Basics of Theory of Operation, Applications – Legacy Applications – New, Applications - Future, Integration of ADAS Technology into Vehicle Electronics, System Examples, Role of Sensor Data Fusion Autonomous Vehicles, Driverless Car Technology, Moral, Legal, Road block Issues, Technical Issues, Security Issues.

**Reference Books:**

1. Electric & Hybrid Vehicles, A.K. Babu, Khanna Publishing House

2. Automotive Fuel Technology-Electric, Hybrid and Fuel-Cell Vehicles: Jack Erjavec& Jeff Arias

3. Electric and Hybrid Vehicles: Design Fundamentals: Iqbal Husain

4. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theoryand Design: Mehrdadehsani, Yimingao, AliEmadi.

5. Mullett, Wireless Telecommunications Systems and Networks, Thomson – Delmar Learning, ISNB#1-4018-8659-0, 2006.

6. Mullett, Basic Telecommunications: The Physical Layer, Thomson – Delmar Learning, ISBN#1-4018-4339-5, 2003

**Course Outcomes:**

Upon completion of this course the students can able

**CO1:** To equip themselves with a solid foundation in advanced automotive technologies.

**CO2:** To enable them to contribute to the design, development, and implementation of electric and hybrid vehicles.

**CO3:** To connect systems, and autonomous driving technologies.

**CO4:** To gain a deep understanding of sensor technologies, control systems, and the integration of electronics in modern vehicles.

**CO5:** To prepare for their careers in the rapidly evolving automotive industry.

## DEPARTMENTAL ELECTIVE - 1

### Implementation of Quality Management System (RAT-011)

**L T P: 3 1 0**

**Course Objectives**

- Understand the Importance of Quality and Comprehend Quality Dimensions
- Learn the Basics of Total Quality Management (TQM): and Explore Contributions of Quality Gurus
- Identify Barriers to TQM Implementation and Develop Strategic Quality Planning Skills:
- Utilize Seven Tools of Quality and Understand Benchmarking Process
- Appreciate Quality Improvement Strategies

**Unit 1** **(8 Hrs)**

**Introduction** – Need for Quality – Definitions of Quality – Dimensions of Product and Service Quality – Basic Concept of TQM – Contributions of Deming, Juran and Crosby – Barriers to TQM.

**Unit 2** **(8 Hrs)**

**Strategic Quality Planning** – Quality Councils – Employee Involvement – Empowerment – Team and Team Work – PDCA Cycle – 5S – Supplier Selection and Supplier Rating.

**Unit 3** **(10 Hrs)**

**Seven Tools Of Quality** – New Management Tool – Concepts, Methodology, Applications to Manufacturing, Service Sector Including IT – Bench Marking – Reason to Bench Mark, Bench Mark Process – FMEA Types.

**Unit 4** **(8 Hrs)**

**Production Planning & Control** – Concepts of Productivity – Importance – Modes of Calculating Productivity – Cost of Quality - SERVQUAL – Quality Improvement Strategies.

**References:**

1. Jiju Antony; David Preece Routledge, ―Understanding, Managing and Implementing Quality: Frameworks, Techniques and Cases‖, Routledge, 2002.

2. Dale H. Besterfield., ―Total Quality Management‖, Pearson, 2011. .

3. Hubert K.Rampersad, ―Total Quality Management‖, Springer International Publishing

**Course Outcomes:**

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

**CO1:** Evaluate Quality Dimensions and apply TQM Principles.

**CO2:** Analyze Quality Contributions and overcome Implementation Barriers.

**CO3:** Develop Strategic Plans and Implement Continuous Improvement by Utilize Quality Tools.

**CO4:** Perform Benchmarking and suggest Quality Improvement Strategies.

**CO5:** Demonstrate Knowledge of Quality Concepts.

## Microcontrollers and Embedded System (RAT-012)

**L T P: 3 1 0**

### Course Objectives

- To understand microprocessors and microcontrollers
- To learn about typical peripherals of microcontrollers
- To learn about development of embedded systems for real world applications

**Unit 1** **(10 Hrs)**

Introduction to Embedded Systems; Architecture – Sensors, Processor: Microprocessor & Microcontroller, Actuator; Classifications of embedded systems; Design process; Applications; Processor - evolution and types. CPU Performance, Performance Metrics and Benchmarks.

**Unit 2** **(10 Hrs)**

An introduction to Embedded Processors. ARM Architecture – Programmer's Model, Instruction Set, Addressing modes, Assembly Programs. Pipelined data path design - Pipeline Hazards. Memory system design- Cache Memory, Memory Management unit, Virtual Memory.

**Unit 3** **(12 Hrs)**

Overview of 8-bit and 16-bit microcontrollers. Introduction to ARM based Microcontrollers – Architecture, Peripherals - Input/Output ports, Timers, ADC, DAC, PWM, Quadrature Encoder, UART, I2C, SPI, Advanced communication interfaces. Interfacing of sensors and actuators. Application development – Robotics & Automation.

### Text / Reference Books

1. Saurabh Chandrakar Nilesh Bhaskarrao Bahadure, "Microcontrollers and Embedded System Design", First Edition, Dreamtech Press, 2019.
2. Joseph Yu, "The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors", Third Edition, Newness, 2013.
3. Steve Furber, "ARM System-on-chip Architecture", Second Edition, Addison Wesley, 2000.
4. Andrew Sloss, Dominic Symes and Chris Wright, "ARM System Developer's Guide: Designing and Optimizing System Software", Morgan Kaufumann Publisher, 2011.
5. William Hohl and Christopher Hinds, "ARM Assembly Language: Fundamentals and Techniques", Second Edition, CRC Press, 2016.

**Course Outcomes**

At the end of the course, the student will be able to:

**CO1:** Identify various hardware and software architectures in embedded systems.

**CO2:** Explain the concepts of microprocessors and microcontrollers.

**CO3:** Describe the detailed architecture, internal modules and addressing modes of ARM based processor.

**CO4:** Analyse microcontroller peripherals and interfacing of sensors and actuators.

**CO5:** Develop robotics and automation applications with microcontrollers.

## Advanced Strength of Materials (RAT-013)

**L T P: 3 1 0**

**Course Objective**

The objective is to present the mathematical and physical principles in understanding the linear continuum behavior of solids.

**Particulars**

**Unit 1** **(8 Hrs)**

**Review of Stress and Strain in 3D:** Introduction to stress in 3D, Stress components on an arbitrary plane, Principal stresses, Stress Invariants, Plane state of stress, Differential equations of equilibrium, Boundary conditions, Strains: Concept of strain, derivation of small strain tensor, Compatibility conditions.

**Unit 2** **(8 Hrs)**

**Relationship Between Elastic Constants for Different Materials:** Introduction to Stress-strain relations for linearly elastic solid, Generalized Hooke's law, Stress-strain relations for isotropic, orthotropic and anisotropic materials, Relations between elastic constants, Material symmetry, Boundary Value Problems, Plane stress and plane strain problems.

**Unit 3** **(8 Hrs)**

**Theories of Failure:** Introduction to theories of failure, Mohr's theory of failure, Ideally plastic solid, Yield surfaces of Trescas and Von-mises, Axisymmetric problems: Lame's problem, Stress on composite tubes, Rotating shafts and cylinders, Thermal stresses: Thermo-elastic stress-strain relations, Strain displacement relations.

**Unit 4** **(8 Hrs)**

**Curved beam and Unsymmetrical Bending**: Curved Beams: Bending of beams with large initial curvature, position of neutral axis for rectangular, trapezoidal and circular cross sections, stress in crane hooks, stress in circular rings subjected to tension or compression.

**Unsymmetrical Bending**: Properties of beam cross-section slope of neutral axis, stress and deflection in unsymmetrical bending, determination of shear center and flexural axis (for symmetry about both axis and about one axis) for I-section and channel section.

**Unit 5** **(8 Hrs)**

**Stress Concentration and Fracture Mechanics:** Introduction to stress concentrations and fracture mechanics: Brittle fracture, Stress intensity factor, Fracture toughness, Fracture modes, Experimental determination of $K_{IC}$, Strain energy release rate, Meaning of energy criterion. Elasto-plastic fracture mechanics, J Integral.

**Reference Books:**

1. G. T. Mase, R. E. Smelser and G. E. Mase, Continuum Mechanics for Engineers, Third Edition, CRC Press, 2004.
2. Y. C. Fung, Foundations of Solid Mechanics, Prentice Hall International, 1965.
3. Lawrence. E. Malvern, Introduction to Mechanics of a Continuous Medium, Prentice Hall international, 1969.

**Course Outcomes**

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

**CO1**: Understand the deformation behavior of solids under different types of loading and obtain mathematical solutions for simple geometries.

**CO2:** Apply the different boundary conditions and superposition theorem to the various type of materials.

**CO3:** Identify and solve the plane stress and plane strain problems subjected to different loads.

**CO4:** Apply the concept of solid mechanics to the cylinders, disks and non-circular cross-sections.

**CO5:** Identify, formulate and solve engineering problems.

**Introduction of Data Science (RAT-014)**

**L T P: 3 1 0**

**Course Objectives**

- To understand various statistical measures for data science
- To understand the concepts of supervised and unsupervised learning techniques.
- To carry out various case studies with data sets from robotics and to draw practical inferences.

**Unit 2** **(12 Hrs)**

Introduction, Causality and Experiments, Data Pre-processing: Data cleaning, Data reduction, Data transformation, Data discretization. Visualization and Graphing: Visualizing Categorical Distributions, Visualizing Numerical Distributions, Overlaid Graphs, plots, and summary statistics of exploratory data analysis and Randomness, Classification of data and representation of data- bar and pie charts – histogram frequency polygon – Box plot. Case studies for different data plots.

**Unit 2** **(8 Hrs)**

Analysis Measures of Central tendency and dispersion - Mean, median, mode, absolute, quartile and standard deviations, skewness and kurtosis for both grouped and ungrouped data. Association of attributes. Case studies.

**Unit 3** **(12 Hrs)**

Supervised Learning (Regression/Classification): Basic methods: Distance-based methods, Nearest-Neighbors, Decision Trees, Naïve Bayes. Linear models: Linear Regression, Logistic Regression, Generalized Linear Models. Support Vector Machines. Unsupervised Learning: Clustering: K-means/Kernel K-means. Dimensionality Reduction: PCA and kernel PCA. Matrix Factorization and Matrix Completion. Case studies for data sets related automations.

**Reference Books:**

1. John Hopcroft and Ravi Kannan, “Foundations of Data Science”, ebook, Publisher, 2013.
2. Artificial Intelligence for Robotics, Francis X. Govers, Packt publishing, 2018.
3. The Art of Data Science, Roger Peng and Elizabeth Matsui, null edition, 2020.
4. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012

5. Data Science and big data analytics: Discovering, analyzing, visualizing and presentating data, EMC Education Services, John Wiley 2015.
6. Introduction to Data Science: A Python Approach to Concepts, Techniques and Applications. Laura Igual, SantiSeguí. Springer Publications (2016).

**Course Outcomes**

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

**CO1:** Understand the various data processing and plotting techniques and apply to some data sets in automations.

**CO2:** Understand and apply various statistical measures to some data sets.

**CO3:** Understand basic concepts of supervised and unsupervised learnings.

**CO4:** Understand the data clustering techniques through various case studies.

## Advanced Materials for Robotics (RAT-015)

**L T P: 3 1 0**

**Course Objective**

The course should enable the students to:

- Provide an overview of advanced materials for robotics and their applications.
- Select appropriate advanced materials for robotics for different engineering applications.
- Gain knowledge about Non Metallic materials, High Strength Materials, low and high temperature materials, nanomaterial and their applications.

**Particulars**

**Unit 1** **(8 Hrs)**

**Advanced Metallic Materials**- Fundamental principles of advanced materials and application of advanced materials to robotics using a multidisciplinary science based approach. Liquid-solid transformation-Nucleation and kinetics of growth, interface morphologies, nonequilibrium freezing, segregation. Nucleation in the solid statetransformations, diffusion in solid state, diffusion equations for steady state and transient conditions, Strengthening methods and mechanisms.

**Unit 2** **(8 Hrs)**

**Structural Materials for Robots** – Aluminium, copper, magnesium, steel, nickel and titanium alloys. Recent advances in materials development- Hi-Entropy alloys, functionally gradient materials, shape memory alloys, metallic composite for soft robotics, computational metamaterials.

**Unit 3** **(8 Hrs)**

**Composites In Robotics**- Types of matrices and reinforcements, principles, properties and applications, stretchable elastomeric sensor and ionic polymer for robotics, kevlar, biodegradable smart materials, macroscopic composites, three-dimensional, periodic cellular architecture. Special processing techniques of material for robotics.

**Unit 4** **(8 Hrs)**

Introduction to thin film sand sensor material, energy material and refractory materials and characterization. Materials characterization techniques for advanced and robotic material – Recap of mechanical, metallurgical, chemical and thermal methods. Instrumentational methods – Scanning electron microscopy, transmission electron

microscopy and energy dispersive analyses, X-ray diffraction, atomic force microscopy, Field array NDT techniques for futuristic materials, surface patterning techniques.

**Reference Books:**


1. Bhushan Bharat, “Springer Handbook of Nanotechnology”, Springer, 2017
2. Sohel Rana and Raul Fangueiro, “Advanced Composite Materials for Aerospace Engineering: Processing, Properties and Applications”, Woodhead Publishing, 2016.
3. Rowe Jason, “Advanced Materials in Automotive Engineering”, Woodhead Publishing, 2016.
4. Cantor Brian, Hazel Assender and Patrick Grant, “Aerospace Materials”, CRC Press, 2015.
5. Park Joon and Roderic S. Lakes, “Biomaterials: an Introduction”, Springer Science & Business Media, 2007.
6. Cao Guozhong, “Nanostructures & Nanomaterials: Synthesis, Properties &Applications”, Imperial College Press, 2004.
7. Michio Inagaki Feiyu Kang Masahiro Toyoda Hidetaka Konno, “Advanced Materials Science and Engineering of Carbon”, 1st Edition, Butterworth-Heinemann, 2013, ISBN: 9780124077898
8. Gaskell, David R., “Introduction to Metallurgical Thermodynamics”, McGraw Hill, 1973
9. W. D. Callister, "Materials Science and Engineering: An Introduction", John Wiley & Sons, 2007.
10. C. Kittel, "Introduction to Solid State Physics" Wiley Eastern Ltd, 2005.
11. Michael Shur, "Physics of Semiconductor Devices", Prentice Hall of India, 1995.
12. Charles P Poole Jr., and Frank J. Ownes, “Introduction to Nanotechnology”, John Wiley Sons, Inc., 2003.
13. M. H. Loretto, “Electron Beam Analysis of Materials”, Chapman and Hall, 1984.
14. Seymour and Carraher, “Polymer chemistry”, Marcel Dekker, 2003Sam Zhang, Lin Li and Ashok Kumar,
15. “Materials Characterization Techniques”, CRC Press, (2008)


**Course Outcomes**

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

**CO1:** Gain knowledge about thermodynamics of nucleation and strengthening mechanisms.

**CO2:** Analyze metallic, functional and polymer materials and its processing.

**CO3:** Acquire knowledge in high performance materials and techniques for robotics.

**CO4:** Analyze structure properties, and performance using advanced material characterization techniques.

## DEPARTMENTAL ELECTIVE - 2

## Design of Machine Elements and Transmission Systems (RAT-016)

**L T P: 3 1 0**

**Course Objective:** To introduce students to the design and theory of common machine elements and to give students experience in solving design problems involving machine elements.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction:** Fundamentals of Machine Design-Engineering Design, Phases of Design, Design Consideration - Standards and Codes - Selection of Materials –Design against Static and Dynamic Load –Modes of Failure, Factor of Safety, Principal Stresses, Theories of Failure-Stress Concentration, Stress Concentration Factors, Variable Stress, Fatigue Failure, Endurance Limit, Design for Finite and Infinite Life, Soderberg and Goodman Criteria.

**Unit 2** **(8 Hrs)**

**Detachable and Permanent Joints:** Design of Bolts under Static Load, Design of Bolt with Tightening/Initial Stress, Design of Bolts subjected to Fatigue – Keys -Types, Selection of Square and Flat Keys-Design of Riveted Joints and Welded Joints

**Unit 3** **(8 Hrs)**

**Shafts and Coupling:** Design of Shaft –For Static and Varying Loads, For Strength and Rigidity-Design of Coupling-Types, Flange, Muff and Flexible Rubber Bushed Coupling

**Unit 4** **(8 Hrs)**

**Gears and Belt Drives**

Design of Spur and Helical Gear drives-Design of Belt drives-Flat and V Belts

**Unit 5** **(8 Hrs)**

**Springs and Bearings:** Design of Helical Spring-Types, Materials, Static and Variable Loads-Design of Leaf Spring-Design of Journal Bearing -Antifriction Bearing-Types, Life of Bearing, Reliability Consideration, Selection of Ball and Roller Bearings

**Text Books:**

1. Joseph Edward Shigley, Charles R. Mischke "Mechanical Engineering Design", McGraw Hill, International Edition, 1992

2. Sharma. C.S. and Kamlesh Purohit, "Design of Machine Elements", Prentice Hall of India Private Limited, 2003

**References:**

1. Bhandari. V.B., "Design of Machine Elements", Tata McGraw-Hill Publishing Company Limited, 2003.

2. Robert L.Norton, "Machin Design – An Integrated Approach", Prentice Hall International Edition, 2000.
Course Outcomes

**Course Outcomes**

At the end of this course, student is able to:

**CO1:** To formulate and analyze stresses and strains in machine elements subjected to various loads.

**CO2:** To analyze and design structural joints such as Riveted joints, welded joints, Bolts.

**CO3:** To analyze and design the components for power transmission like shaft and couplings.

**CO4:** To analyze and design different types of gears and belts for engineering applications.

**CO5:** To analyze and design mechanical springs and bearings.

# Optimization Techniques in Engineering (RAT-017)

**L T P: 3 1 0**

**Course Objective**

To study the principles of optimization and various techniques used for mechanical engineering optimization along with applications.

**Particulars**

**Unit 1** **(8 Hrs)**

Unconstrained Optimization: Optimizing Single-Variable Functions, conditions for Local Minimum and Maximum, Optimizing Multi-Variable Functions.

**Unit 2** **(8 Hrs)**

**Constrained Optimization:** Optimizing Multivariable Functions with Equality Constraint: Direct Search Method, Lagrange Multipliers Method, Constrained Multivariable Optimization with inequality constrained: Kuhn-Tucker Necessary conditions, Kuhn –Tucker Sufficient Conditions.

**Unit 3** **(10 Hrs)**

**Optimization:** Quasi-Newton Methods and line search, least squares optimization, Gauss Newton, Levenberg-Marquartd, Extensions of LP to Mixed Integer Linear Programming (MILP), Non-Linear Programming, The Newton Algorithm, Non-Linear Least Squares, Sequential Quadratics Programming (SQP), Constrained Optimization, SQP Implementation, Multi-Objective Optimization, Branch and Bound Approaches, Genetic Algorithms and Genetic Programming, Singular Based Optimization, On-Line Real- Time Optimization, Optimization in Econometrics Approaches – Blue.

**Unit 4** **(8 Hrs)**

Optimization and Functions of a Complex Variable and Numerical Analysis: The Finite Difference Method for Poisson's Equation in two Dimensions and for the Transient Heat Equation, Eulers Method, The Modified Euler Method and the Runge-Kutta Method for Ordinary Differential Equations, Gaussian Quardative Trapezoidal Rule and Simpson's 1/3 and 3/8 Rules, the Newton Raphson in one and two Dimensions, Jacobi's Iteration Method.

**Unit 5** **(8 Hrs)**

Optimization in Operation Research: Dynamic Programming, Transportation – Linear Optimization Simplex and Hitchcock Algorithms, Algorithms, Minimax and Maxmin Algorithm, Discrete Simulation, Integer Programming – Cutting Plane Methods, Separable Programming, Stochastic Programming, Goal Programming, Integer Linear Programming, Pure and Mixed Strategy in theory of Games, Transhipment Problems, Heuristic Methods.

**Reference Books:**


1. Rao Singaresu.S, "Engineering Optimization – Theory & Practice", New Age International (P) Limited,New Delhi, 2009.
2. Kalyanamoy Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall ofIndia Pvt. Ltd., 2006.
3. Johnson Ray C, "Optimum design of mechanical elements", Wiley, John & Sons, Digitized 2007
4. Goldberg .D.E, "Genetic algorithms in search, optimization and machine", Barnen, Addison Wesley, New York, 1989.
5. William Orthwein, "Machine Component Design", Vol. I and II, Jaico Publishing house, New Edition, 2006.
6. Rao.C.S, "Optimization Techniques", Dhanpat Rai & Sons, New Delhi
7. Fox.R.L, "Optimization methods for Engineering Design", Addison Wesley Pub, Digitized 2007.
8. Garret N. Vanderplaats, "Numerical optimization techniques for engineering", McGraw-Hill Ryerson, Limited, 1984.


**Course Outcomes**

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

**CO1**: Define and use optimization terminology and concepts, and understand how to classify an optimization problem.

**CO2**: Demonstrate the ability to choose and justify optimization techniques that are appropriate for solving realistic engineering problems.

**CO3**: Understand and apply unconstrained optimization theory for continuous problems, including the necessary and sufficient optimality conditions and algorithms.

**CO4**: Understand and apply gradient-free and discrete optimization algorithms.

**CO5**: Apply optimization techniques to determine a robust design.

## Finite Element Method (RAT-018)

**L T P: 3 1 0**

**Course Objective**

To illustrate the principle of mathematical modelling of engineering problems and to introduce the basics and application of Finite Element Method.

**Particulars**

**Unit 1** **(8 Hrs)**

Historical Background, Mathematical modeling of field problems in engineering, governing equations, discrete and continuous models, boundary and initial value problems, Weighted Residual Methods, Variational formulation of boundary value problems, Ritz technique, Basic concept of Finite Element Method.

**Unit 2** **(8 Hrs)**

One dimensional second order equation, discretization, linear and higher order elements, derivation of shape functions, Stiffness matrix and force vectors, assembly of elemental matrices, solution of problems from solid mechanics and heat transfer, longitudinal vibration and mode shapes, fourth order beam equation, transverse deflections and natural frequencies.

**Unit 3** **(8 Hrs)**

Trusses: Introduction, plane trusses, three dimensional trusses, assembly of global stiffness matrix for the banded and skyline solution.

Beams and Frames: Introduction, finite element formulation, load vector, boundary considerations, shear force and bending moment, plane frames.

**Unit 4** **(8 Hrs)**

Two dimensional equations, variational formulation, finite element formulation, triangular elements- shape functions, elemental matrices and RHS vectors; application to thermal problems, torsion of non-circular shafts, quadrilateral and higher order elements. Plane stresses and plane strain problems, body forces and thermal loads, plate and shell elements.

**Unit 5** **(8 Hrs)**

Natural coordinate systems, iso-parametric elements and shape functions, numerical integration and application to plane stress problems, matrix solution techniques, solution of dynamic problems and introduction to FE software.

**Reference Books:**

1. Rao S.S., The Finite Element Method in Engineering, 3rd ed., Butterworth Heinemann, 2004.
2. Chandrupatla & Belegundu, Introduction to Finite Elements in Engineering, 3rd ed., Prentice Hall, 1990.
3. Reddy J.N., An Introduction to Finite Element Method, 3rd ed., Tata McGraw Hill, 2005.
4. Seshu P., Text Book of Finite Element Analysis, Prentice Hall, New Delhi, 2007.

**Course Outcomes**

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

**CO1**: Understand the FEM formulation and its application to simple structural and thermal problems.

**CO2**: Understand the numerical methods involved in Finite Element Theory.

**CO3**: Analyze the direct and formal (basic energy and weighted residual) methods for deriving finite element equations.

**CO4**: Analyze the role and significance of shape functions in finite element formulations and use linear, quadratic, and cubic shape functions for interpolation.

**CO5**: Design and analyze the complicated systems.

## Computer Architecture (RAT-019)

**L T P: 3 1 0**

**Course Objective**

- To learn the basic structure and operations of a computer.
- To learn the arithmetic and logic unit and implementation of fixed-point and floating-point arithmetic unit.
- To learn the basics of pipelined execution.
- To understand parallelism and multi-core processors.
- To understand the memory hierarchies, cache memories and virtual memories.
- To learn the different ways of communication with I/O devices.

**Particulars**

**Unit 1** **(8 Hrs)**

**Basic Structure of a Computer System:** Functional Units – Basic Operational Concepts – Performance – Instructions: Language of the Computer – Operations, Operands – Instruction representation – Logical operations – decision making – MIPS Addressing.

**Unit 2** **(8 Hrs)**

**Arithmetic for Computers:** Addition and Subtraction – Multiplication – Division – Floating Point Representation – Floating Point Operations – Subword Parallelism.

**Unit 3** **(8 Hrs)**

**Processor and Control Unit:** A Basic MIPS implementation – Building a Data path – Control Implementation Scheme – Pipelining – Pipelined data path and control – Handling Data Hazards & Control Hazards – Exceptions.

**Unit 4** **(8 Hrs)**

**Parallelism:** Parallel processing challenges – Flynn's classification – SISD, MIMD, SIMD, SPMD, and Vector Architectures - Hardware multithreading – Multi-core processors and other Shared Memory Multiprocessors - Introduction to Graphics Processing Units, Clusters, Warehouse Scale Computers and other Message-Passing Multiprocessors.

**Unit 5** **(8 Hrs)**

**Memory & I/O Systems:** Memory Hierarchy - memory technologies – cache memory – measuring and improving cache performance – virtual memory, TLB's – Accessing I/O Devices – Interrupts – Direct Memory Access – Bus structure – Bus operation – Arbitration – Interface circuits - USB.

**Text Books:**

1. David A. Patterson and John L. Hennessy, Computer Organization and Design: The Hardware/Software Interface, Fifth Edition, Morgan Kaufmann / Elsevier, 2014.
2. Carl Hamacher, Zvonko Vranesic, Safwat Zaky and Naraig Manjikian, Computer Organization and Embedded Systems, Sixth Edition, Tata McGraw Hill, 2012.

**References:**

1. William Stallings, Computer Organization and Architecture – Designing for Performance, Eighth Edition, Pearson Education, 2010.
2. John P. Hayes, Computer Architecture and Organization, Third Edition, Tata McGraw Hill, 2012.
3. John L. Hennessey and David A. Patterson, Computer Architecture – A Quantitative Approach, Morgan Kaufmann / Elsevier Publishers, Fifth Edition, 2012.

**Course Outcomes**

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

**CO1:** Understand the basics structure of computers, operations and instructions.
**CO2**: Design arithmetic and logic unit.
**CO3:** Understand pipelined execution and design control unit.
**CO4:** Understand parallel processing architectures.
**CO5:** Understand the various memory systems and I/O communication.

## Advanced Welding Technology (RAT-020)

**L T P: 3 0 0**

**Course Objectives**

The course should enable the student to:

- Impart knowledge of various parameters and requirements of welding processes and advanced welding practices in industries.
- Understand the weldability of specific materials.
- Acquire knowledge about the principle and applications of advance welding processes.
- Gain the knowledge of weld design, defects and its remedies.
- Know the thermal and metallurgical considerations of welds.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction:** Importance and application of welding, classification of welding process; Selection of welding process; Arc and Power Source characteristics, Review of conventional welding process: Gas welding, Arc welding, MIG, TIG welding, Resistance welding. Electroslag welding, Friction welding etc., Soldering & Brazing.

**Unit 2** **(8 Hrs)**

**Weldability of Specific Materials:** Weldability of: Carbon steel, High strength low alloy steels, stainless steel, Cast Iron, Copper and its alloys, Aluminum and its alloys, Magnesium and its alloys and Titanium alloys& Maurer/Schacfflar Diagram.

**Unit 3** **(8 Hrs)**

**Advanced Welding Techniques:** Principle, working and application of advanced welding techniques such as Plasma Arc welding, Laser beam welding, Electron beam welding, Ultrasonic welding, explosive welding, Underwater welding, Spray welding /Metallising, Hard facing.

**Unit 4** **(8 Hrs)**

**Weld Design:** Weld defects and distortion and its remedies, Inspection/testing of welds, HAZ, Weld Design, Welding of pipe-lines and pressure vessels. Life prediction.

**Unit 5** **(8 Hrs)**

**Thermal and Metallurgical Considerations:** Thermal considerations for welding, temperature distribution, Analytical analysis, heating & cooling curves. Metallurgical consideration of weld, HAZ and Parent metal, micro & macro structure. Solidification of weld and properties.

**Reference Books:**

1. Welding Engineering & Technology by R. S. Parmar, Khanna Publishers.
2. Welding Processes and Technology by R.S. Parmar, Khanna Publishers.
3. Principles of welding (Processes, Physics, Chemistry, and Metallurgy) Robert W. Messler Wiley Publishers.
4. Advanced Welding Processes by John Norrish, Woodhead Publishing.
5. Welding Metallurgy by Sindo Kou, Wiley-Interscience Publication.
6. Welding Handbook (Vol-2, 3 & 4) by American Welding Society.

**Course Outcomes**

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

**CO1:** Acclaim knowledge regarding various advanced welding practices in industries.

**CO2:** Understand various parameters and requirements of welding processes.

**CO3:** Know the comparative merits and demerits of various welding processes

**CO4:** Understand the right kind of welding techniques suitable for various joints.

**CO5:** Learn about the joint designs adopted in different types of welding techniques

## Modern Automated and Intelligent Electric Vehicles Lab (RAP-008)

**L T P: 0 0 2**

**Course Objective**

This laboratory course focuses on the practical analysis of various electric vehicle (EV) subsystems using simulators. Students will engage in hands-on activities to study and compare charging stations, control systems, battery cooling systems, battery monitoring systems, emission control systems, and control units. Through simulation-based experiments, students will gain insight into the operation, performance, and optimization of these essential EV components.

**List of Experiments:**

1. Study and compare different charging stations.
2. Analysis of different control system on Simulator.
3. Analysis of Battery Cooling System on Simulator.
4. Analysis of Battery Monitoring System on Simulator.
5. Analysis of Emission control system on Simulator
6. Analysis of Control Units on Simulator.

**Course Outcomes:**

At the end of the course, student will be able to:

**CO1:** Successful understand about the different parts/components of this course.

**CO2:** Utilize Simulation Tools and Compare EV Subsystems.

**CO3:** Optimize System Performance and Identify System Interactions.

**CO4:** Propose Solutions and Communicate Findings

**CO5:** Collaborate in Teams and Apply Knowledge.

## CNC Machine and Metrology Lab (RAP-009)

**L T P: 0 0 2**

**Course Objectives**

The course should enable the students to:

- Impart knowledge in CNC programming for turning and milling operations
- Use measuring systems for the geometrical measurement of gears and threads.
- Know the measurement of Taper Angle using Sine Bar and other measuring instruments.

**List of Experiments:**

1. Study of the CNC machine

2. Programming and simulation of a lathe using any CAM package.

3. Programming and simulation of a machining centre using any CAM package.

4. Programming and operation of a CNC Lathe.

5. Programming and operation of a CNC machining centre.

6. Measurement of Taper Angle using Sine Bar.

7. Optical profile projector – study of profile of gear tooth, screw threads.

8. Tool maker's microscope – to study cutting tool geometry, screw threads.

9. Tool wear and surface finish measurement.

10. Dimensional measurement of machined components using, bore gauge, air gauge and Height master

**Course Outcomes**

At the end of the course, student will be able to:

**CO1:** Understand the features and operation of CNC machines.

**CO2:** Prepare CNC program from the component drawings.

**CO3:** Learn the usage of profile projectors and tool maker's microscopes.

## Pneumatics and Hydraulic Systems Lab (RAP-010)

**L T P: 0 0 2**

**Course Objectives**

- To introduce the concepts of low-cost automation.
- Familiarize with the pneumatics and electro-pneumatics system.

**List of Experiments:**

1. Design the pneumatic circuits for a given application.
2. Design the industrial fluid power circuit.
3. Design of multiple cylinder sequence (cascade method) with timer.
4. Design of multiple cylinder sequence (cascade method) without timer.
5. Design of multiple cylinder sequence (cascade method) with pneumatic counter.
6. Design of electro pneumatic circuit.
7. Design of electro pneumatic circuit for multiple cylinders sequence.
8. Design of electro pneumatic circuit with various sensors.
9. Design of electro pneumatic circuit for multiple cylinders sequence using PLC.
10. Design the fluid power circuit for Industrial application.
11. Maintenance and troubleshooting of pneumatic components.

**Course Outcomes:**

At the end of the course, the student will be able to:

**CO1:** Develop the pneumatic circuit the given application

**CO2:** Develop the electro- pneumatic circuit the given application

**CO3:** Maintenance and troubleshooting of pneumatic components

## Internship II/ Mini Project II (RAP-011)

### Course Objectives

The course should enable the students to:

- Create an Industrial environment and culture within the institution.
- Identify the issues and challenges of an industry.
- Prepare report on the application of emerging technologies in the selected industry.
- Learn and understand the concept of entrepreneurship.
- Inculcate innovative thinking.

### Course Outcomes:

On completion of the course, student will be able to–

**CO1:** Develop his abilities to transmit technical information clearly and test the same by delivery of Seminar based on the Mini Project or Internship.

**CO2:** Understand the importance of document design by compiling Technical Report on the Mini Project or Internship work carried out.

**CO3:** Comment and evaluate other students research questions and internship proposals.

## Constitution of India (AHT-009)

**L T P: 2 0 0**

### Course Objectives

The course should enable the students to:

- Acquaint them with legacies of constitutional development in India and help to understand the most diversified legal document of India and philosophy behind.
- Make them aware of the theoretical and functional aspects of the Indian Parliamentary System.
- Channelize their thinking towards basic understanding of the legal concepts and its implications for engineers.

### Particulars

**Unit 1** **(8 Hrs)**

**Constitutional Framework**

Meaning of Terms and Phrases frequently used in political system like constitution, constitutionalism, Rule of Law, Federal system, Government and so on. Historical Background of Indian Constitution, Making of Indian Constitution, Salient features of Indian Constitution, Preamble of Indian Constitution.

**Unit 2** **(8 Hrs)**

**Different Parts, Articles, and their Significance**

Part I to IVA (Union and its territories w.r.t. Indian States, Citizenship, Fundamental Rights conferred to citizens and foreigners, Directive Principles of State Policy– Its importance and implementation and Fundamental Duties and its legal status), Article 1 to 51A and their significance.

**Unit 3** **(8 Hrs)**

**System of Government**

Parliamentary Form of Government in India – The constitution powers and status of the President of India, Federal structure and distribution of legislative and financial powers between the Union and the States, Emergency Provisions: National Emergency, President Rule, Financial Emergency and Amendment of the Constitutional Powers and Procedure and the significance of basic structure in Indian Judicial system.

**Unit 4** **(8 Hrs)**

**Working of Central, State & Local Self Government as per Constitution**

Framework for central government (President, Vice president, Prime Minister, Central council of ministers, Parliament, Supreme court and so on), Framework for state government (Governor, Chief Minister, state legislature, High court and so on) and Framework for local self government (Panchayatiraj, Municipalities) and Union Territories.

**Unit 5** **(8 Hrs)**

**Constitutional, Non-Constitutional and other bodies**

Discussion on Various constitutional bodies like Election Commission, UPSC, SPSC, Finance commission, NCSC, NCST, NCBC, CAG and AGI. Discussion on Various non-constitutional bodies like NITI Aayog, NHRC, CIC, CVC, CBI, Lokpal and Lokayukta. Discussion on Various other constitutional bodies like Co-operative societies, Official Language, Tribunals etc.

**Text/Reference Books-**

1- M. Laxmikanth, “Indian Polity”, McGraw- Hill, 6th edition, 2020
2- D.D. Basu, “Introduction to the Indian Constitution”, LexisNexis, 21st edition, 2020
3- S.C. Kashyap, “ Constitution of India”, Vitasta publishing Pvt. Ltd., 2019

**Course Outcomes**

The course should enable the students to:

**CO1:** Understand the basic knowledge and salient features of Indian Constitution.

**CO2:** Identify and explore the basic features and modalities about Indian constitution.

**CO3:** Discusses the essence of Union and its territories, Citizenship, Fundamental Rights, DPSP and Fundamental Duties.

**CO4:** Differentiate and relate the functioning of Indian parliamentary system at the center and state level.

**CO5:** Differentiate different aspects of Indian Legal System and its related bodies.

## Essence of Indian Traditional Knowledge (AHT-010)

**L T P: 2 0 0**

### Course Objectives

The course should enable the students:

- With the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.
- To understand the traditional knowledge and analyse it and apply it to their day to day life.
- To know the need and importance of protecting traditional knowledge.
- To understand the concepts of Intellectual property to protect the traditional knowledge.
- For concentrating on various acts in protecting the environment and Knowledge management impact on various sectors in the economy development of the country.

### Particulars

**Unit 1** **(8 Hrs)**

**Introduction to Traditional and Culture Knowledge**

Define culture, traditional, civilization and heritage knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK). Indigenous traditional knowledge Vs western traditional knowledge vis-à-vis formal knowledge.

**Unit 2** **(8 Hrs)**

**Protection of Traditional Knowledge**

Protection of traditional knowledge: The need for protecting traditional knowledge Significance of traditional knowledge Protection, value of traditional knowledge in global economy, Role of Government to harness traditional knowledge.

**Unit 3** **(8 Hrs)**

**Traditional Knowledge and Intellectual Property**

Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, Global legal forums for increasing protection of Indian Traditional Knowledge.

**Unit 4** **(8 Hrs)**

**Traditional Knowledge in Different Sectors**

Traditional knowledge in engineering, biotechnology and agriculture, traditional medicine system, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of traditional knowledge.

**Unit 5** **(8 Hrs)**

**Education System in India**

Education in ancient, medieval and modern India, aims of education, subjects, languages, Science and Scientists of Ancient India, Scientists of Medieval India, Scientists of Modern India. The role Gurukulas in Education System, Value based Education.

**Text/Reference Books:**


1. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.
2. "Knowledge Traditions and Practices of India" Kapil Kapoor1, Michel Danino2.
3. Traditional Knowledge System in India, by Amit Jha, 2009.
4. Satya Prakash, “Founders of Sciences in Ancient India”, Vijay Kumar Publisher, 1989
5. Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh Pratibha Prakashan 2012.


**Course Outcomes**

The course should enable the students to:

**CO1:** Understand the concept of Traditional knowledge and its importance.

**CO2:** Know the need and importance of protecting traditional knowledge.

**CO3:** Know the various enactments related to the protection of traditional knowledge.

**CO4:** Understand the concepts of Intellectual property to protect the traditional knowledge.

**CO5:** Know the contribution of scientists of different areas.

| B.TECH. (ROBOTICS AND AUTOMATION) SEMESTER-VI | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **S. No** | **Subject Codes** | **Category** | **Subject** | **Periods** | | | **Evaluation Scheme** | | | | | **Subject Total** | **Credit** |
| | | | | | | | **Sessional Exam** | | | **ESE** | | | |
| | | | | **L** | **T** | **P** | **CT** | **TA** | **Total** | **TE** | **PE** | | |
| 1 | RAT-021 | DC | Power Electronics and Drives | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 2 | RAT-022 | DC | Design of Machine Elements | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 3 | RAT-023 | DC | Robotics and Material Handling System | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 4 | RAT-XXX | DE | Departmental Elective - 3 | 3 | 0 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 5 | | HSC | Open Elective-1 | 3 | 0 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 6 | RAP-012 | DLC | MATLAB Programming for Mechanical Engineers | 0 | 0 | 2 | | 25 | 25 | | 25 | 50 | 1 |
| 7 | RAP-013 | DLC | Design of Machine Elements Lab | 0 | 0 | 2 | | 25 | 25 | | 25 | 50 | 1 |
| 8 | RAP-014 | DLC | Project Stage -I | 0 | 0 | 2 | | 25 | 25 | | 25 | 50 | 1 |
| 9 | AHT-009/ AHT-010 | NC | Essence of Indian Traditional Knowledge / Constitution of India | 2 | 0 | 0 | 15 | 10 | 25 | 50 | | 75 | 0 |
| 10 | ATH-014 | NC | Happiness and Well Being | 2 | 0 | 0 | 25 | 25 | 50 | | | 50 | 0 |
| 11 | GP-06 | NC | General Proficiency | | | | | | 50 | | | 50 | |
| | | | **Total** | **17** | **3** | **6** | | | | | | **900** | **21** |
| 12 | | | Open Elective (Optional) | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| Mini Project-III or Internship-III*<br>To be completed at the end of sixth semester (during Summer Break) & its evaluation/credit to be added in seventh semester. | | | | | | | | | | | | | |

| Code | Departmental Elective - 3 |
|---|---|
| RAT-024 | Programmable Logic Controllers |
| RAT-025 | Field and Service Robotics |
| RAT-026 | Introduction to Machine Learning |
| RAT-027 | Industrial Automation |
| RAT-028 | Internet of Things |

## Power Electronics and Drives (RAT-021)

**L T P: 3 1 0**

**Course Objective**

The course should enable the students to:

- Comprehensive introduction to various power electronic devices, their structure, operating principle and characteristics.
- Give exposure to various topologies, working principle and analysis of controlled rectifiers and ac controllers.
- Detailed knowledge on Classifications, structure, operating principle of dc choppers.
- Introduction to different types of Inverters, their principle of operation and waveform control.
- Overview on dc and ac drives and their control using power electronic circuits.

**Particulars**

**Unit 1** **(8 Hrs)**

**Power Semiconductor Devices and Characteristics:** Operating principle and switching Characteristics: Power diodes, Power BJT, Power MOSFET, IGBT, SCR, TRIAC, GTO, MCT, Power integrated circuits (PIC) – Drive and Protection circuits – Series and parallel operation – Commutation – Simulation tools.

**Unit 2** **(8 Hrs)**

**Controlled Rectifiers and AC Controllers:** Single phase – Three phase – Half controlled – Fully controlled rectifiers – Dual converters -Effect of source and load inductance - AC voltage controllers –Introduction to Cyclo converters, Matrix converters.

**Unit 3** **(8 Hrs)**

**DC To DC Converters:** Step up and Step down Chopper – Chopper classification - quadrant of operation – Switching mode Regulators – Buck, Boost, Buck-Boost, and Cuk Regulators.

**Unit 4** **(8 Hrs)**

**Inverters :** Voltage source Inverters – Half bridge – Full bridge – Three Phase Bridge Inverters – Voltage control– PWM Techniques – Current Source Inverters: Capacitor Commutated Inverter- Resonant inverters: Series, Parallel, ZVS, ZCS – Introduction to multilevel Inverters.

**Unit 5** **(8 Hrs)**

**Drives and Control:** Static and Dynamic equations of dc and ac machines – Electrical breaking – Rectifier and chopper control of DC drives – Principles of v/f control of AC drives – Open loop and Closed loop schemes for DC and AC drives(Block diagram approach only) – Introduction to vector control of AC drives.

**Text Books:**

1. Rashid, M.H., "Power Electronics – Circuits, Devices and Applications", PHI, 3rd Edition, 2004.
2. Mohan, Udeland and Robbins, "Power Electronics", John Wiley and Sons, New York, 1995.

**References:**

1. Singh, M.D., and Khanchandani, K.B., "Power Electronics", 2nd Edition, Tata McGraw-Hill, 2011.
2. Bose, B.K., "Modern Power Electronics and AC Drives", Pearson Education, 2002.
3. Bimbra, P.S., "Power Electronics", Khanna Publishers, 2006.
4. Moorthi, V.R., "Power Electronics - Devices, Circuits and Industrial Applications", Oxford University Press, 2005.
5. NPTEL Lecture Series on "Power Electronics" by Dr.B.G.Fernandes, IIT Bombay.

**Course Outcomes**

At the end of the course, student will be able to:

**CO1:** Explain various devices and their structure, operating characteristics in the field of electronics.

**CO2:** Classify, analyze and design, Control rectifier, chopper and inverter.

**CO3:** Apply power electronic circuits for the control of popular applications.

**CO4:** Design and analyze PE circuit using simulation software.

**CO5:** Understand the Static and Dynamic Equations of DC and AC Machines, Electrical Braking, Rectifier and Chopper Control of DC Drives.

## Design of Machine Elements (RAT-022)

**L T P: 3 1 0**

### Course Objectives

The course will enable the student to:

- Learn the basics of machine design, material selection criterion, design against static and fluctuating loads.
- Explain the design process for joints like welded & screwed under eccentric and fatigue loading and design of shaft, keys and couplings.
- Teach stresses in power screws, design process of screw jack and also design of helical and leaf springs.
- Gain knowledge about the classification, selection and design of various types of gears and bearings with the help of design data book.
- Provide an appreciation of the relationships between component level design and overall machine system design and performance.

### Particulars

**Unit 1** **(8 Hrs)**

**Introduction:** Definition, Methods, standards in design & selection of preferred size. Selection of materials for static & fatigue loads, BIS system of designation of steels. AISI (American Iron & Steel Institution), ASTM.

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

**Unit 2** **(9 Hrs)**

**Design against static load:** Modes of failure, Factor of safety, stress-strain relationship, principal stresses, theories of Failure, Design of Cotter and Knuckle Joint under static load.

**Design against fluctuating load:** stress concentration, stress concentration factors, Fluctuating/alternating stresses, fatigue failure, endurance limit, design for finite & infinite life, Soderberg & Goodman criteria.

**Unit 3** **(9 Hrs)**

**Design of Joints:** Welded joint, screwed joints, eccentric loading of above joints, Joint design for fatigue loading.

**Shaft, keys & coupling:** Design against static and fatigue loads, strength & rigidity design, Selection of square & flat keys & splines, rigid & flexible couplings.

**Unit 4** **(10 Hrs)**

**Design of Bearing:** Sliding Contact Bearing: Types, Selection of bearing, Plain journal bearing, Hydrodynamic lubrication, Properties and materials, Lubricants and lubrication, Hydrodynamic journal bearing, Heat generation, Design of journal bearing, Thrust bearing-pivot and collar bearing, Hydrodynamic thrust bearing.

**Rolling Contact Bearing:**Advantages and disadvantages, Types of ball bearing, Thrust ball bearing, Types of roller bearing, Selection of radial ball bearing, Bearing life, Selection of roller bearings, Dynamic equivalent load for roller contact bearing under constant and variable loading, Reliability of Bearing, Selection of rolling contact bearing, Lubrication of ball and roller bearing, Mounting of bearing.

**Design Analysis of Power Screws:** Form of threads, square threads, trapezoidal threads, stresses in screw, design of screw jack.

**Unit 5** **(10 Hrs)**

**Mechanical Springs:** Design of Helical and leaf springs, against static & fatigue loading.

**Design of Transmission Elements:**Spur Gears: Tooth forms, System of gear teeth, contact ratio, Standard proportions of gear systems, Interference in involute gears, Backlash, Selection of gear materials, Gear manufacturing methods, Design considerations, Beam strength of gear tooth, Dynamic tooth load, Wear strength of gear tooth, Failure of gear tooth, Design of spur gears, AGMA and Indian standards.

**Helical Gears:** Terminology, Proportions for helical gears, Beam strength and wear strength of helical gears, herringbone gears, crossed helical gears, Design of helical gears.

**Worm Gears:** Types of worms, Terminology, Gear tooth proportions, Efficiency of worm gears, Heat dissipation in worm gearing, Strength and wear tooth load for worm gears, Design of worm gearing.

**Reference Books:**

1. Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw-Hill International; 1989.
2. Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan, 1992.
3. Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley, 1994.
4. Spottes, M.F., Design of Machine elements, Prentice-Hall India, 1994.
5. R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall, 1998.
6. V. B. Bhandari, Design of Machine Elements, Tata McGraw Education Hill Pvt Ltd India.

**Course Outcomes**

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

**CO1:** Explain the different standard system for designating engineering materials.

**CO2:** Design of Helical and leaf springs, against static & fatigue loading.

**CO3:** Design of Joints, Shaft, keys & coupling.

**CO4:** Design of bearing and power screw.

**CO5:** Design of transmission elements like gears.

## Robotics and Material Handling Systems (RAT-023)

**L T P: 3 1 0**

**Course Objectives**

The course will enable the student:

- To introduce the basic concepts, parts of robots and types of robots.
- To make the student familiar with the various drive systems for robot, sensors and their applications in robots and programming of robots.
- To select the robots according to its usage.
- To discuss about the various applications of robots, justification and implementation of robot.
- To know about material handling in a system.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction:** Types of industrial robots, Load handling capacity, general considerations in Robotic material handling, material transfer, machine loading and unloading, CNC machine tool loading, Robot centered cell.

**Unit 2** **(8 Hrs)**

**Robots for Inspection:** Robotic vision systems, image representation, object recognition and categorization, depth measurement, image data compression, visual inspection, software considerations.

**Unit 3** **(8 Hrs)**

**Other Applications:** Application of Robots in continuous arc welding, Spot welding, Spray painting, assembly operation, cleaning, robot for underwater applications.

**Unit 4** **(8 Hrs)**

**End Effectors:** Gripper force analysis and gripper design, design of multiple degrees of freedom, active and passive grippers.

**Selection of Robot**: Factors influencing the choice of a robot, robot performance testing, economics of robotisation, Impact of robot on industry and society.

**Unit 5** **(8 Hrs)**

**Material Handling:** Concepts of material handling, principles and considerations in material handling systems design, conventional material handling systems - industrial trucks, monorails, rail guided vehicles, conveyor systems, cranes and hoists, advanced material handling systems, automated guided vehicle systems, automated storage and retrieval systems(ASRS), bar code technology, radio frequency identification technology.

**Text Books:**

1. Richaerd D Klafter, Thomas Achmielewski and Mickael Negin, “Robotic Engineering – An integrated Approach” Prentice HallIndia, New Delhi, 2001.

2. Mikell P. Groover, ”Automation, Production Systems, and Computer Integrated Manufacturing“, 2nd Edition, John Wiley & sons, Inc, 2007

**References:**

1. James A Rehg, “Introduction to Robotics in CIM Systems”, Prentice Hall of India, 2002.

2. Deb S R, "Robotics Technology and Flexible Automation", Tata McGraw Hill, New Delhi, 1994 Course

## Course Outcomes

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

**CO1**: Learn about the basic concepts, parts of robots and types of robots.
**CO2:** Design automatic manufacturing cells with robotic control using the principle behind robotic drive system, end effectors, sensor, machine vision robot kinematics and programming.
**CO3:** Select the required robot.
**CO4:** Know various applications of robots.
**CO5:** Apply their knowledge in handling the materials.

## DEPARTMENTAL ELECTIVE - 3

## Programmable Logic Controllers (RAT-024)

**L T P: 3 1 0**

### Course Objectives

The objective of this course is to provide students with a comprehensive understanding of Programmable Logic Controllers (PLCs), their hardware components, input/output devices, and programming fundamentals. By the end of the course, students should be able to:

- Understand PLC Basics and Familiarize with PLC Hardware.
- Understand Interfacing Input/Output Devices.
- Understand Interfacing Output Devices.
- Master PLC Programming Basics and Develop Programming Skills.
- Apply Concepts to Real-world Scenarios.

### Particulars

**Unit 1** **(10 Hrs)**

**PLC Basics**: Programmable Logic Controllers (PLCs): Introduction; definition & history of the PLC; Principles of Operation; Various Parts of a PLC: CPU & programmer/ monitors; PLC input & output modules; Solid state memory; the processor; I/O modules; power supplies. PLC advantage & disadvantage; PLC versus Computers, PLC Application. Programming equipment; proper construction of PLC ladder diagrams; process scanning consideration; PLC operational faults.

**Unit 2** **(8 Hrs)**

PLC Hardware Components The I/O section, Discrete I/O Modules, Analog I/O Modules, Special I/O Modules, I/O specifications, The CPU, Memory design, Memory Types, Programming Devices, Selection of wire types and size.

**Unit 3** **(8 Hrs)**

Various INPUT /OUTPUT Devices and its interfacing with PLC. Different types of Input devices: Switches: Push button Switches, Toggle Switches, Proximity switches, Photo switches, Temperature Switch, Pressure Switch,

and Level Switch Flow Switches, manually operated switches, Motor starters, Transducers and sensors, Transmitters etc. Their working, specification and interfacing with PLC. Different types of Output devices: Electromagnetic Control Relays, Latching relays, Contactors, Motors, Pumps, Solenoid Valves etc. Their working, specification and interfacing with PLC.

**Unit 4** **(10 Hrs)**

Basics of PLC Programming Processor Memory Organization, Program Scan, PLC Programming languages, Relay type instructions, Instruction addressing, Branch Instructions, Internal Relay Instructions, Programming Examine if Closed and examine If Open instructions, Entering the ladder diagram, Modes of operation. Creating Ladder Diagrams from Process Control Descriptions. Ladder diagram & sequence listing; large process ladder diagram construction, flow charting as programming method, Industrial Examples.

**Reference Books:**

1. Introduction to Programmable Logic Controllers, Gray Dunning, Delamar Thomson Learning, 1998.
2. Programmable Controllers- An Engineers's Guide, 2nd Edition, E.A. Parr, Newnes, 1999.
3. Programmable controllers, Hardware, Software & Applications, George L. Batten Jr., McGraw Hill, 2nd Edition, 1994.
4. Programmable logic controllers, W. Bolton, Elsevier Ltd, 2015.
5. Programmable logic controllers, Frank D Petruzella, McGraw-Hill, 2011.
6. Programmable Logic Controllers: Programming Methods and Applications. John R Hackworth and Fredrick D Hackworth Jr., Pearson Education, 2006.

**Course Outcomes**

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

**CO1:** Comprehensive understanding of PLC concepts, including their history, functioning, advantages, and disadvantages compared to computers.

**CO2:** Hardware expertise of various components of PLC hardware, understanding memory types, and selecting appropriate wire types and sizes.

**CO3:** Device interfacing of interfacing different types of input and output devices with PLCs, including switches, sensors, relays, motors, and valves.

**CO4:** Programming proficiency of PLC programming, including ladder diagram construction, addressing methods, branching, and internal relay instructions.

**CO5:** Practical application in real-world scenarios, develop PLC programs based on process control descriptions, and troubleshoot common operational faults.

## Field and Service Robotics (RAT-025)

**L T P: 3 1 0**

**Course Objectives**

The course will enable the students to study:

- The various parts of robots and fields of robotics.
- The various kinematics and inverse kinematics of robots.
- About the localization, planning and navigation.
- About the control of robots for some specific applications.
- About the humanoid robots.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction:** History of service robotics – Present status and future trends – Need for service robots - applications- examples and Specifications of service and field Robots. Non-conventional Industrial robots.

**Unit 2** **(8 Hrs)**

**Localization:** Introduction-Challenges of Localization- Map Representation- Probabilistic Map based Localization- Monte Carlo localization- Landmark based Navigation-Globally unique localization- Positioning beacon systems- Route based localization.

**Unit 3** **(8 Hrs)**

**Planning and Navigation:** Introduction-Path planning overview- Road map path planning- Cell decomposition path planning- Potential field path Planning-Obstacle avoidance - Case studies: tiered robot architectures.

**Unit 4** **(8 Hrs)**

**Field Robots:** Ariel robots- Collision Avoidance-Robots for agriculture, mining, exploration, underwater, civilian and military applications, nuclear applications, Space applications.

**Unit 5** **(8 Hrs)**

**Humanoids:** Wheeled and legged, Legged locomotion and balance, Arm movement, Gaze and auditory orientation control, Facial expression, Hands and manipulation, Sound and speech generation, Motion capture/Learning from demonstration, Human activity recognition using vision, touch, sound, Vision, Tactile

Sensing, Models of emotion and motivation. Performance, Interaction, Safety and robustness, Applications, Case studies.

**Text Books:**

1. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, “Introduction to Autonomous Mobile Robots”, Bradford Company Scituate, USA, 2004

2. Riadh Siaer, “The future of Humanoid Robots- Research and applications“, Intech Publications, 2012.

**References:**

1. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India P Ltd., 2006.

2. Kelly, Alonzo; Iagnemma, Karl; Howard, Andrew, "Field and Service Robotics ", Springer, 2011

**Course Outcomes**

At the end of the course, the student will be able to:

**CO1:** Explain the basic concepts of working of robot.

**CO2:** Analyze the function of sensors in the robot.

**CO3:** Write program to use a robot for a typical application.

**CO4:** Use Robots in different applications.

**CO5:** Know about the humanoid robots.

# Introduction to Machine Learning (RAT-026)

**L T P: 3 1 0**

## Course Objectives

The course will enable the students to:

- Learn and understand the basic concepts and techniques of Machine Learning.
- Develop skills of using recent machine learning software for solving practical problems.
- Become familiar with the application of machine learning in robotics.

## Particulars

### Unit 1 (8 Hrs)

Basic motivation, examples of machine learning applications, supervised and unsupervised learning – Review linear algebra, vector spaces, linear transformations, Eigen values and vectors – Review of probability theory, random variables, probability distributions – Linear Regression in one variable, Gradient descent, Regression in multiple variables – Linear models for classification, Discriminant functions, Logistic regression – Regularization, over and under fitting, Regularized linear regression, Regularized logistic regression.

### Unit 2 (8 Hrs)

Neural networks model representation, Feed-forward network functions, Network training, Back-propagation algorithm – Clustering, Mixture densities, K-Means clustering, Expectation maximization, Spectral clustering – Dimensionality reduction, Principal component analysis, Singular value decomposition.

### Unit 3 (6 Hrs)

Reinforced learning – Fundamentals of deep learning – Application of machine learning in robotics.

### Unit 4 (8 Hrs)

Instance Based Learning: introduction, K-nearest neighbour learning, locally weighted regression, case-based reasoning.

Learning set of rule: introduction, sequential covering algorithm, learning rule sets, first order rules.

**Unit 5** **(8 Hrs)**

Analytical learning: introduction, perfect domain theory, explanation based learning. Inductive analytical approaches to learning.

**Reference Books**:

1. Tom M. Mitchell, Machine Learning, McGraw Hill, 1997.
2. EthemAlpaydin, Introduction to Machine Learning, MIT Press, 2014.
3. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
4. A. C. Muller and S. Guido, Introduction to Machine Learning with Python, O'Reilly Media, 2016.
5. A. C. Faul, A Concise Introduction to Machine Learning, CRC Press, 2020

**Course Outcomes**

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

**CO1:** Able to generate, analyze and interpret data summaries.
**CO2:** Able to carry out analysis on machine learning algorithms.
**CO3:** Able to design and implement classifiers for machine learning applications.
**CO4:** Able to apply machine learning algorithm in robotics.
**CO5:** Able to apply inductive analytical approaches to learning.

# Industrial Automation (RAT-027)

**L T P: 3 1 0**

**Course Objectives**

To provide the student with basic skills useful in identifying the concepts of automation using hydraulics, pneumatics, industrial sensors, PLC and distributed control strategies.

**Particulars**

## Unit 1 (8 Hrs)

Introduction to Automation: Fundamentals of automation, necessity and architecture of automated systems. Principles and architectures for automation in industry. Levels of automation, automation safety, maintenance, error detection and repair diagnostics. Elements of automated system, types of systems such as hydraulic, pneumatic, hybrid systems. Assembly-line automation - Conveyor, part feeders, material transport systems, and automated assembly.

## Unit 2 (8 Hrs)

Hydraulic and Pneumatic Systems in Automation: Hydraulics: Fluid properties, Pascal's Law and applications, Fluid power symbols, Hydraulic pumps, Sizing of Pumps, Pump Performance, Characteristics and Selection, Control valves: Direction control valves, Pressure control valves, Flow control valves, Hydraulic Proportional Valves, Servo valves. Accumulator- types, application circuits. Design and analysis of typical Industrial hydraulic circuits. Accessories used in fluid power system, Filtration systems and maintenance of system.

## Unit 3 (8 Hrs)

Pneumatics: Gas laws, Preparation of air, Fluid conditioning elements, Actuators, Sizing of Actuators, Control valves: Direction control valves, Pressure control valves, Flow control valves. Development of single and multiple actuator circuits. Valves for logic functions; Time delay valve; Exhaust and supply air throttling, Pneumatic circuit design: Cascade method, step – counter method. Fluid logic devices. Circuits using Fluid logic devices and applications

## Unit 4 (8 Hrs)

Programmable Logic Controllers: Basic Structure, Input / Output Processing, Programming with Timers, Internal relays and counters, Shift Registers, Master and Jump Controls. Data Handling, Analogs Input / Output. Electrical controls for Fluid power circuits.

**Unit 5** **(8 Hrs)**

Distributed Control System: Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.

**Text Books**


- Antony Espossito, “Fluid power with Applications ", Pearson, Sixth Edition., 2003.
- W. Bolton, “Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering” – PrenticeHall - 2013 – 5th Edition
- Singh, Shio Kumar. Industrial Instrumentation & Control, Tata McGraw-Hill Education, 2010.


**Reference Books**


- Sullivan James A., “Fluid Power - Theory and Applications”, Fourth Edition, Prentice Hall International, NewJersey, 1998.
- Petruzella, Frank D. Programmable logic controllers. Tata McGraw-Hill Education, 2005.
- Watton, John. Fundamentals of fluid power control. Vol. 10. Cambridge University Press, 2009.
- Mikell Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, 5th Edition, Pearson, 2019.
- Jon Stenerson, Industrial Automation and Process Control, Pearson, 2003.
- Frank Lamb, Industrial Automation: Hands On, McGraw-Hill Education, 2013.


**Course Outcomes**

At the end of the course, the student will be able to:

**CO1:** Identify the automation need, type and method

**CO2:** Demonstrate the functioning of fluid power components

**CO3:** Design fluid power circuits for the given application

**CO4:** Design PLC program for the given application

**CO5:** Design and implement a closed loop system for automation.

## Internet of Things (RAT-028)

**L T P: 3 1 0**

**Course Objectives**

The course will enable the students to:

- Learn the fundamentals of IoT
- Provides skills for IoT based application development
- Covers basics needed for selection of sensors, protocols, and hardware boards
- Use addresses implementation of IoT concepts for application building.

**Particulars**

**Unit 1** **(12 Hrs)**

Basic of computer networks – ISO/OSI protocol stack – TCP/IP protocol stack – Layers & Services. Introduction to IoT - IoT definition - Characteristics - Things in IoT - IoT Complete Architectural Stack - IoT enabling Technologies - IoT Challenges. Sensors and Hardware for IoT. Hardware Kits - Arduino, Raspberry Pi, Node MCU. A Case study with any one of the boards and data acquisition from sensors.

**Unit 2** **(12 Hrs)**

Protocols for IoT - infrastructure protocol IPV4/V6|RPL), Identification (URLs), Transport (WiFi, LiFi, BLE), Discovery, Data Protocols, Device Management Protocols. - A Case Study with MQTT/CoAP usage. Cloud Computing - Types of Cloud – Challenges in IoT with cloud - Selection of cloud for IoT applications – Fog computing for IoT - Edge computing for IoT - Cloud security aspects for IoT applications - Case study with AWS / AZURE / Adafruit / IBM Bluemix. Everything as a service (XaaS).

**Unit 3** **(8 Hrs)**

Case studies with architectural analysis: IoT applications - Industrial IoT, Smart City - Smart Water – Smart Agriculture - Smart Energy - Smart Healthcare - Smart Transportation - Smart robotic systems.

**Reference Books:**

1. Bahga A, Madisetti V. Internet of Things: A hands-on approach; 2014.
2. Tanenbaum A S. Computer Networks. Fifth Edition, Pearson Education India; 2013.

3. Shriram K Vasudevan, Abhishek SN and Sundaram RMD. Internet of Things, First Edition, Wiley India; 2019.
4. Raj P, Raman AC. The Internet of things: Enabling Technologies, Platforms, and Use-cases. Auerbach Publications; 2017.
5. Adrian McEwen. Designing the Internet of Things, Wiley; 2013.

**Course Outcomes**

At the end of the course, student will be able to:

**CO1:** Identify the key techniques and theory behind Internet of Things.

**CO2:** Apply various enabling technologies (both hardware and software) for IoT.

**CO3:** Perform the integration of Cloud and IoT, Edge and Fog Computing.

**CO4:** Apply various techniques for Data Accumulation, Storage and Analytics.

**CO5:** Design and build IoT system for any one interesting use case.

## MATLAB Programming for Mechanical Engineers (RAP-012)

**L T P: 0 0 2**

### Course Objectives

The course should enable the students to:

- Learn programming using MATLAB.
- Learn basic concepts of MATLAB.
- Get Hands-on exposure of MATLAB.
- Solve the complex problems in few modules of computer programs.
- Build indispensable skill to compete in today's job market.

### Particulars

**Unit 1**

**Starting with MATLAB:** Working in the command window, arithmetic operations with scalars, using MATLAB as a calculator, display formats, elementary math built-in functions, defining scalar variables, useful commands for managing variables, script files, examples of MATLAB applications.

**Creating Arrays:** Creating a one-dimensional array (vector), creating a two-dimensional array (matrix), notes about variables in MATLAB, the transpose operator array addressing, using a colon: in addressing arrays, adding elements to existing variables, deleting elements, built-in functions for handling arrays, strings and strings as variables problems.

**Unit 2**

**Mathematical Operations with Array:** Addition and subtraction, array multiplication, array division, element-by-element operations, using arrays in MATLAB built-in math functions, built-in functions for analyzing arrays, generation of random numbers, examples of MATLAB applications.

**Using Script Files and Managing Data:** MATLAB workspace and the workspace window, input to a script file, output commands, the save and load commands, importing and exporting data, examples of MATLAB applications.

**Unit 3**

**Two-Dimensional Plots:**The plot command, plot of given data, plot of a function, the fplot command, plotting multiple graphs in the same plot, formatting a plot, plots with logarithmic axes, plots with error bars, plots with special graphics, histograms, polar plots, putting multiple plots on the same page, multiple figure windows, examples of MATLAB application.

**Programming with MATALAB:** Relational and logical operators, conditional statements, the switch-case statement, loops, nested loops and nested conditional statements, the break and continue commands, examples of MATLAB applications.

**Unit 4**

**User-Defined Functions and Function Files:** Creating a function file, structure of a function file, local and global variables, saving a function file using a user-defined function, examples of simple user-defined functions, comparison between script files and function files, anonymous and inline functions, function functions, subfunctions, nested functions, examples of MATLAB applications.

**Polynomials, Curve Fitting, and Interpolation:** Polynomials, value of a polynomial, roots of a polynomial, addition, multiplication, and division of polynomials, derivatives of polynomials, curve fitting, interpolation, the basic fitting interface, examples of MATLAB applications.

**Unit 5**

**Applications in Numerical Analysis:** Solving an equation with one variable, finding a minimum or a maximum of a function, numerical integration, ordinary differential equations, examples of MATLAB applications. Introductory lesson for differentiation, integration, solving an ordinary differential equation.

**Three-Dimensional Plots:** Line plots, mesh and surface plots, plots with special graphics, the view command, examples of MATLAB applications.

**Reference Books:**

1. Amos Gilat. MATLAB an introduction with applications. John Wiley & Sons.
2. Fausett L.V. (2007) Applied Numerical Analysis Using MATLAB, 2nd Ed., Pearson Education.
3. Chapra S.C. and Canale R.P. (2006) Numerical Methods for Engineers, 5th Ed., McGraw Hill.

**Course Outcomes**

After this course students will be capable of:

**CO1**: Forming the 1 and 2-dimensional array and preparing 2 and 3 dimensional plots using MATLAB.

**CO2**: Managing script files and data and doing programming in MATLAB.

**CO3**: Preparing 2 dimensional plots using MATLAB and writing and applying UDF

**CO4**: Understanding the engineering problem domain and doing curve fitting and interpolation.

**CO5**: Applying the logic for solving the complex problem and applying MATLAB in numerical analysis.

## Design of Machine Elements Lab (RAP-013)

**L T P: 0 0 2**

### Course Objectives

The course will enable the student to:

- Amplify the understanding about designing different mechanism.
- Learn about the design of different joints.
- Learn the procedure of machine design and develop an ability to apply it practically for design of various machine components and joints.
- Understand use of Design Data Hand Book and ISO standards for selection of materials, strengths, standard dimensions.

### Particulars

List of experiments (Minimum 10 of the following)

1. Failure analysis of machine elements using FEM software
2. Design & drawing of Helical Spring.
3. Design & drawing of Leaf Spring.
4. Design & drawing of Riveted joints for given operating conditions.
5. Design of an eccentrically loaded welded, riveted of bolted joint.
6. Design of bolted joint for fluctuating loads.
7. Design of Rigid Coupling for given operating condition.
8. Design of Flexible Coupling for given operating condition.
9. To study and Design of Spur and Helical Gear
10. To study of Sliding Contact Bearing
11. To study of Rolling Contact Bearing
12. Design a shaft used in some practical application, by actual working and loading conditions
13. Design of helical and leaf springs.
14. Any other suitable experiment on Machine Design.

**Reference Books:**

1. Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw-Hill International; 1989.
2. Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan, 1992.
3. Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley, 1994.
4. Spottes, M.F., Design of Machine elements, Prentice-Hall India, 1994.
5. R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall, 1998.
6. V. B. Bhandari, Design of Machine Elements, Tata McGraw Education Hill Pvt Ltd India

**Course Outcomes:**

At the end of the course, student will be able to:

**CO1:** Study of failure behaviour of mechanical components.

**CO2:** Evaluate and design the different types of joints.

**CO3:** Analyse and design the various gears including spur and helical.

**CO4:** Analyse and design the different bearings.

**CO5:** Analyse and design the helical and leaf springs.

**Project Stage - I (RAP-014)**

## Course Objectives

The course should enable the students:

- To allow students to demonstrate a wide range of the skills learned during their course of study
- To encourage multidisciplinary research through the integration learned in a number of courses.
- To allow students to develop problem solving, analysis, synthesis and evaluation skills.
- To encourage teamwork.
- To improve students' communication skills by asking them to produce both a professional report and to give an oral presentation

## Course Outcomes

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

**CO1:** Demonstrate a sound technical knowledge of their selected project topic.

**CO2:** Undertake problem identification, formulation and solution.

**CO3:** Combine the theoretical and practical concepts studied in his / her academics.

**CO4:** Communicate with engineers and the community at large in written and oral forms.

**CO5:** Demonstrate the knowledge, skills and attitudes of a professional engineer.

## Essence of Indian Traditional Knowledge (AHT-009)

**L T P: 2 0 0**

### Course Objectives

The course should enable the students:

- With the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.
- To understand the traditional knowledge and analyse it and apply it to their day to day life.
- To know the need and importance of protecting traditional knowledge.
- To understand the concepts of Intellectual property to protect the traditional knowledge.
- For concentrating on various acts in protecting the environment and Knowledge management impact on various sectors in the economy development of the country.

### Particulars

**Unit 1** **(8 Hrs)**

**Introduction to Traditional and Culture Knowledge:** Define culture, traditional, civilization and heritage knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK). Indigenous traditional knowledge Vs western traditional knowledge vis-à-vis formal knowledge.

**Unit 2** **(8 Hrs)**

**Protection of Traditional Knowledge:** Protection of traditional knowledge: The need for protecting traditional knowledge Significance of traditional knowledge Protection, value of traditional knowledge in global economy, Role of Government to harness traditional knowledge.

**Unit 3** **(8 Hrs)**

**Traditional Knowledge and Intellectual Property:** Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, Global legal forums for increasing protection of Indian Traditional Knowledge.

**Unit 4** **(8 Hrs)**

**Traditional Knowledge in Different Sectors:** Traditional knowledge in engineering, biotechnology and agriculture, traditional medicine system, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of traditional knowledge.

**Unit 5** **(8 Hrs)**

**Education System in India:** Education in ancient, medieval and modern India, aims of education, subjects, languages, Science and Scientists of Ancient India, Scientists of Medieval India, Scientists of Modern India. The role Gurukulas in Education System, Value based Education.

**Text/Reference Books:**


1. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.
2. "Knowledge Traditions and Practices of India" Kapil Kapoor1, Michel Danino2.
3. Traditional Knowledge System in India, by Amit Jha, 2009.
4. Satya Prakash, "Founders of Sciences in Ancient India", Vijay Kumar Publisher, 1989
5. Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh Pratibha Prakashan 2012.


**Course Outcomes**

The course should enable the students to:

**CO1:** Understand the concept of Traditional knowledge and its importance.

**CO2:** Know the need and importance of protecting traditional knowledge.

**CO3:** Know the various enactments related to the protection of traditional knowledge.

**CO4:** Understand the concepts of Intellectual property to protect the traditional knowledge.

**CO5:** Know the contribution of scientists of different areas.

## Constitution of India (AHT-010)

**L T P: 2 0 0**

### Course Objectives

The course should enable the students to:

- Acquaint them with legacies of constitutional development in India and help to understand the most diversified legal document of India and philosophy behind
- Make them aware of the theoretical and functional aspects of the Indian Parliamentary System.
- Channelize their thinking towards basic understanding of the legal concepts and its implications for engineers.

### Particulars

**Unit 1** **(8 Hrs)**

**Constitutional Framework:** Meaning of Terms and Phrases frequently used in political system like constitution, constitutionalism, Rule of Law, Federal system, Government and so on. Historical Background of Indian Constitution, Making of Indian Constitution, Salient features of Indian Constitution, Preamble of Indian Constitution.

**Unit 2** **(8 Hrs)**

**Different Parts, Articles, and their Significance:** Part I to IVA (Union and its territories w.r.t. Indian States, Citizenship, Fundamental Rights conferred to citizens and foreigners, Directive Principles of State Policy– Its importance and implementation and Fundamental Duties and its legal status), Article 1 to 51A and their significance.

**Unit 3** **(8 Hrs)**

**System of Government:** Parliamentary Form of Government in India – The constitution powers and status of the President of India, Federal structure and distribution of legislative and financial powers between the Union and the States, Emergency Provisions: National Emergency, President Rule, Financial Emergency and Amendment of the Constitutional Powers and Procedure and the significance of basic structure in Indian Judicial system.

**Unit 4** **(8 Hrs)**

**Working of Central, State & Local Self Government as per Constitution:** Framework for central government (President, Vice president, Prime Minister, Central council of ministers, Parliament, Supreme court and so on), Framework for state government (Governor, Chief Minister, state legislature, High court and so on) and Framework for local self government (Panchayatiraj, Municipalities) and Union Territories.

**Unit 5** **(8 Hrs)**

**Constitutional, Non-Constitutional and other Bodies:** Discussion on Various constitutional bodies like Election Commission, UPSC, SPSC, Finance commission, NCSC, NCST, NCBC, CAG and AGI. Discussion on Various non-constitutional bodies like NITI Aayog, NHRC, CIC, CVC, CBI, Lokpal and Lokayukta. Discussion on Various other constitutional bodies like Co- operative societies, Official Language, Tribunals etc.

**Text/Reference Books-**

1- M. Laxmikanth, “Indian Polity”, McGraw- Hill, 6th edition, 2020
2- D.D. Basu, “Introduction to the Indian Constitution”, LexisNexis, 21st edition, 2020
3- S.C. Kashyap, “ Constitution of India”, Vitasta publishing Pvt. Ltd., 2019

**Course Outcomes**

The course should enable the students to:

**CO1:** Understand the basic knowledge and salient features of Indian Constitution.

**CO2:** Identify and explore the basic features and modalities about Indian constitution.

**CO3:** Discusses the essence of Union and its territories, Citizenship, Fundamental Rights, DPSP and Fundamental Duties.

**CO4:** Differentiate and relate the functioning of Indian parliamentary system at the center and state level.

**CO5:** Differentiate different aspects of Indian Legal System and its related bodies.

## Happiness and Well Being (AHT-014)

**L T P: 2 0 0**

**Course Objectives**

The course should enable the students to:

- Obtain a basic understanding of Positive emotions, strengths and virtues; the concepts and determinants of happiness and well-being.
- Bring an experience marked by predominance of positive emotions and informing them about emerging paradigm of Positive Psychology.
- Build relevant competencies for experiencing and sharing happiness as lived experience and its implication.
- Become aware of contextual and cultural influences on health and happiness.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction to Positive Psychology:** Importance of positive emotions in everyday life and society, Positive Emotions and well being: Hope & Optimism, Love. The Positive Psychology of Emotional Intelligence, Influence of Positive Emotions Strength and Virtues; implications for human behavior and mental health.

**Unit 2** **(8 Hrs)**

**Happiness:** Determinants of Happiness and well-being – biological, social, psychological and spiritual, Types of happiness- Eudaimonic and Hedonic, Traits associated with Happiness, Setting Goals for Life and Happiness, Research findings on effects of happiness and well-being on mental illness and stress.

**Unit 3** **(8 Hrs)**

**Resilience and Well Being:** Meaning, Nature and Approaches Theories of Resilience, Positive Response to loss, Post Traumatic Growth, Models of PTG as Outcome, Models of PTG as a Coping Strategy Benefit Finding, Mindfulness and Positive Thinking, Building Resilience and Wellbeing.

**Unit 4** **(8 Hrs)**

**Happiness and Well-being in the Indian Context:** Indian philosophy of happiness and life satisfaction. – Karma, Moksha and destiny. Theory of happiness and wellbeing in Taittiriya Upanishad, Role of socio-demographic and cultural factors in Happiness and well-being. Health and Happiness in contemporary India – rural and urban differences and similarities.

**Unit 5** **(8 Hrs)**

**Positive Work Life:** Employee engagement- what causes individuals to join an organization and why they stay or leave, person-centered approach to engagement Understand the concept of work as meaning, Impact of employee well-being on the organization and impact of feelings about work on the individual's well-being. Bringing Positive Psychology to Organizational Psychology.

**Reference Books:**


1- Dandekar, R. N. (1963). On dharma. In De Bary (ed.) Sources of Indian Tradition. Delhi, India: Motilal Banarasidass Publishers.

2- Dandekar R. N. (1981). Exercises in Indology. Delhi, India: Ajanta Publishers.

3- Snyder, C.R., &Lopez,S.J.(2007). Positive psychology: The scientific and practical explorations of human strengths. Thousand Oaks, CA: Sage. Snyder, C. R., & Lopez, S. (Eds.). (2002). Handbook of positive psychology. New York: Oxford University Press.

4- Seligman, M. (2011). Flourish: A Visionary New Understanding of Happiness and Well-being, Atria Books.

5- Peterson, C. A. (2006). A Primer in Positive Psychology, Oxford University Press.

6- Nettle, D.S. (2006). Happiness: The Science Behind Your Smile, Oxford University Press.

7- Lyubomirsky, S. (2013). The Myths of Happiness: What Should Make You Happy, but Doesn't, What Shouldn't Make You Happy, but Does, Penguin


**Course Outcomes:**

The course should enable the students to:

**CO1:** Provide an insight to see the importance of positive emotions, Strength and Virtues in everyday life and society.

**CO2:** Use the strength and virtues in improving human behavior and mental health.

**CO3:** Understand the biological, social, psychological and spiritual determinants of Happiness and well-being.

**CO4:** Throw light on research findings related to effects of happiness and well-being on mental illness and stress.

**CO5:** Give an insight of the Indian philosophy of happiness and life satisfaction in context of Karma, Moksha and destiny and role of socio-demographic and cultural factors in Happiness and well-being.

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY
*(Formerly Uttarakhand Technical University, Dehradun Established by Uttarakhand State Govt. wide Act no. 415 of 2005)*
*Suddhowala, PO-Chandanwadi, Premnagar, Dehradun, Uttarakhand (Website- www.uktech.ac.in)*

# SYLLABUS

**For**

## B.TECH

## (Robotics & Automation Engineering)

## 4th Year

Effective from – Session 2025-26

| B.TECH. (ROBOTICS AND AUTOMATION) SEMESTER-VII | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sl. No** | **Subject Codes** | **Category** | **Subject** | **Periods** | | | **Evaluation Scheme** | | | | | **Subject Total** | **Credit** |
| | | | | | | | **Sessional Exam** | | | **ESE** | | | |
| | | | | **L** | **T** | **P** | **CT** | **TA** | **Total** | **TE** | **PE** | | |
| 1 | AHT-015/ AHT-016 | HSC | HSMC -1 / HSMC-2 | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 2 | RAT-XXX | DE | Departmental Elective-4 | 3 | 0 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 3 | RAT-XXX | DE | Departmental Elective-5 | 3 | 0 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 4 | AHT-XXX | OE | Open Elective-2 | 3 | 0 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 5 | RAP-008 | DLC | Project Seminar | 0 | 0 | 2 | | | 50 | | | 50 | 1 |
| 6 | RAP-009 | DLC | Project Stage -II | 0 | 0 | 4 | | | 100 | | | 100 | 2 |
| 7 | RAP-010 | DLC | Mini Project-III or Internship-III* | 0 | 0 | 2 | | | 50 | | | 50 | 1 |
| 8 | AHT-017 | MC | Disaster Management | 3 | 0 | 0 | | 50 | 50 | | 100 | 150 | 3 |
| 9 | AHT-018 | NC | Innovations and Problem Solving (Audit Course) | 2 | 1 | 0 | 15 | 10 | 25 | 50 | | 75 | 0 |
| 10 | GP-07 | NC | General Proficiency | | | | | | 50 | | | 50 | 0 |
| | | | **Total** | **12** | **1** | **12** | | | | | | **950** | **19** |
| 11 | | | Open Elective (Optional) | 3 | 1 | 0 | 30 | 20 | 50 | 50 | | 150 | 4 |
| *The Internship-III (4-6 weeks) conducted during summer break after VI semester and will be assessed during VII semester | | | | | | | | | | | | | |

| **Departmental Elective - 4** | | **Departmental Elective - 5** | |
|---|---|---|---|
| RAT-029 | Artificial Intelligence for Robotics | RAT-034 | Intelligent Control Systems |
| RAT-030 | Mechanical Vibrations | RAT-035 | 3D Printing and Rapid Prototyping |
| RAT-031 | Automation in Engineering | RAT-036 | TQM & Reliability Engineering |
| RAT-032 | Design of Jigs, Fixture and Press Tools | RAT-037 | Smart Sensors |
| RAT-033 | Medical Robots | RAT-038 | Electric drives |

| | | |
|---|---|---|
| HSMC-1 | AHT-015 | Rural Development, Administration and Planning |
| HSMC-2 | AHT-016 | Project Management & Entrepreneurship |

# HSMC-1

## Rural Development: Administration and Planning (AHT-015)

**L T P: 3 1 0**

**Course Objectives**

This course enables the students to:

- Gain knowledge on the concepts related to administration, its importance and various approaches of Development Administration.
- Gain skills on New Public Management, Public Grievances and Redressal Mechanisms, Accountability and Transparency in Administration and e-governance in the rural development sector.
- Develop their competency on the role of Bureaucracy in Rural Development.

**Particulars**

**Unit 1** **(8 Hrs)**

**Rural Planning & Development:** Concepts of Rural Development, Basic elements of rural Development, and Importance of Rural Development for creation of Sustainable Livelihoods, An overview of Policies and Programmes for Rural Development- Programmes in the agricultural sector, Programmes in the Social Security, Programmes in area of Social Sector.

**Unit 2** **(8 Hrs)**

**Rural Development Programmes:** Sriniketan experiment, Gurgaon experiment, Marthandam experiment, Baroda experiment, Firkha development scheme, Etawapilot project, Nilokheri experiment, approaches to rural community development: Tagore, Gandhi etc.

**Unit 3** **(8 Hrs)**

**Panchayati Raj & Rural Administration:** Administrative Structure: bureaucracy, structure of administration; Panchayati Raj Institutions Emergence and Growth of Panchayati Raj Institutions in

India; People and Panchayati Raj; Financial Organizations in Panchayati Raj Institutions, Structure of rural finance, Government & Non-Government Organizations / Community Based Organizations, Concept of Self help group.

**Unit 4** **(8 Hrs)**

**Human Resource Development in Rural Sector:** Need for Human Resource Development, Elements of Human Resource Development in Rural Sector Dimensions of HRD for rural development-Health, Education, Energy, Skill Development, Training, Nutritional Status access to basic amenities – Population composition.

**Unit 5** **(8 Hrs)**

**Rural Industrialization and Entrepreneurship:** Concept of Rural Industrialization, Gandhian approach to Rural Industrialization, Appropriate Technology for Rural Industries, Entrepreneurship and Rural Industrialization- Problems and diagnosis of Rural Entrepreneurship in India, with special reference to Women Entrepreneurship; Development of Small Entrepreneurs in India, need for and scope of entrepreneurship in Rural area.

**Text Books/References:**

1. Corporate Social Responsibility: An Ethical Approach - Mark S. Schwartz.

2. Katar Singh: Rural Development in India – Theory History and Policy.

3. Todaro M.P. Economic Development in III World war.

4. Arora R.C – Integrated Rural Development in India.

5. Dhandekar V.M and Rath N poverty in India.

6. A.N.Agarwal and Kundana Lal: Rural Economy of India.

7. B.K.Prasad: Rural Development-Sarup & Son’s Publications.

**Course Outcomes**

After completion of the course student will be able to:

CO1: Understand the definitions, concepts and components of Rural Development.

CO2: Students will know the importance, structure, significance, resources of Indian rural economy.

CO3: Students will have a clear idea about the area development programmes and its impact.

CO4: Students will be able to acquire knowledge about rural entrepreneurship.

CO5: Students will be able to understand about the using of different methods for human resource planning.

# HSMC-2

## Project Management & Entrepreneurship (AHT-016)

**L T P: 3 1 0**

**Course Objectives**

The course should enable the students to:

- Understand the concepts of Project Management for planning to execution of projects.
- Understand the feasibility analysis in Project Management and network analysis tools for cost and time estimation.
- Be capable to analyze, apply and appreciate contemporary project management tools and methodologies in Indian context.
- Understand the concepts of Entrepreneurship, role of entrepreneur in economic development, steps for establishing an enterprise.

**Particulars**

**Unit 1** **(8 Hrs)**

**Entrepreneurship:** Entrepreneurship: need, scope, Entrepreneurial competencies & traits, Factors affecting entrepreneurial development, Entrepreneurial motivation (McClellend's Achievement motivation theory), conceptual model of entrepreneurship, entrepreneur vs. intrapreneur; Classification of entrepreneurs; Entrepreneurial Development Programmes.

**Unit 2** **(8 Hrs)**

**Entrepreneurial Idea and Innovation**: Introduction to Innovation, Entrepreneurial Idea Generation and Identifying Business Opportunities, Management skills for Entrepreneurs and managing for Value Creation, Creating and Sustaining Enterprising Model & Organizational Effectiveness.

**Unit 3** **(8 Hrs)**

**Project Management:** Project management: meaning, scope & importance, role of project manager; project life-cycle Project appraisal: Preparation of a real time project feasibility report containing Technical appraisal, Environmental appraisal, Market appraisal (including market survey for forecasting future demand and sales) and Managerial appraisal.

**Unit 4** **(8 Hrs)**

**Project Financing:** Project cost estimation & working capital requirements, sources of funds, capital budgeting, Risk & uncertainty in project evaluation , preparation of projected financial statements viz. Projected balance sheet, projected income statement, projected funds & cash flow statements, Preparation of detailed project report, Project finance.

**Unit 5** **(8 Hrs)**

**Social Entrepreneurship:** Social Sector Perspectives and Social Entrepreneurship, Social Entrepreneurship Opportunities and Successful Models, Social Innovations and Sustainability, Marketing Management for Social Ventures, Risk Management in Social Enterprises, Legal Framework for Social Ventures.

**Case study and presentations:** Case study of successful and failed entrepreneurs. Power point presentation on current business opportunities.

**Text Books**

1. Innovation and Entrepreneurship by Drucker, P.F.; Harperand Row.
2. Business, Entrepreneurship and Management: Rao, V.S.P.;Vikas
3. Entrepreneurship: Roy Rajeev.
4. Text Book of Project Management: Gopal krishnan, P.and Ramamoorthy,V.E.; McMill.
5. Project Management for Engineering, Business and Technology: Nicholas, J.M., and Steyn, H.; PHI.
6. Project Management: The Managerial Process: Gray, C.F., Larson, E.W. and Desai, G.V.; MGH.

**Course Outcomes**

After completion of the course student will be able to:

**CO1:** Understand project characteristics and various stages of a project.

**CO2:** Understand the conceptual clarity about project organization and feasibility analyses – Market, Technical, Financial and Economic.

**CO3:** Analyze the learning and understand techniques for Project planning, scheduling and Execution Control.

**CO4:** Describe Entrepreneurship, Examine role of entrepreneur in economic development.

**CO5:** Describe the steps to establish an enterprise.

## DEPARTMENTAL ELECTIVE -4

### Artificial Intelligence for Robotics (RAT-029)

**L T P: 3 1 0**

**Course Objectives**

The course will enable the students to:

- Study the concepts of Artificial Intelligence.
- Learn the methods of solving problems using Artificial Intelligence.
- Introduce the concepts of Expert Systems and machine learning.
- Learn about planning and reasoning Artificial Intelligence.
- Solve the risk in Artificial Intelligence.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction:** History, state of the art, Need for AI in Robotics. Thinking and acting humanly, intelligent agents, structure of agents.

**Problem Solving:** Solving problems by searching –Informed search and exploration–Constraint satisfaction problems–Adversarial search, knowledge and reasoning–knowledge representation – first order logic.

**Unit 2** **(8 Hrs)**

**Planning:** Planning with forward and backward State space search – Partial order planning – Planning graphs– Planning with propositional logic – Planning and acting in real world.

**Unit 3** **(8 Hrs)**

**Reasoning:** Uncertainity – Probabilistic reasoning–Filtering and prediction–Hidden Markov models–Kalman filters– Dynamic Bayesian Networks, Speech recognition, making decisions.

**Unit 4** **(8 Hrs)**

**Learning:** Forms of learning – Knowledge in learning – Statistical learning methods –reinforcement learning, communication, perceiving and acting, Probabilistic language processing, perception.

**Unit 5** **(8 Hrs)**

**AI in Robotics:** Robotic perception, localization, mapping- configuring space, planning uncertain movements, dynamics and control of movement, Ethics and risks of artificial intelligence in robotics.

**Text Books:**

1. Stuart Russell, Peter Norvig, "Artificial Intelligence: A Modern Approach", Pearson Education, India 2003.

2. Negnevitsky, M, "Artificial Intelligence: A guide to Intelligent Systems", Harlow: Addison-Wesley, 2002.

**Reference:**

1. David Jefferis, "Artificial Intelligence: Robotics and Machine Evolution", Crabtree Publishing Company, 1992.

**Course Outcomes**

After completion of this course, the students should be able to:

**CO1:** Identify problems that are amenable to solution by AI methods.

**CO2:** Identify appropriate AI methods to solve a given problem.

**CO3:** Formalise a given problem in the language/framework of different AI methods.

**CO4:** Implement basic AI algorithms.

**CO5:** Design and carry out an empirical evaluation of different algorithms on a problem formalisation, and state the conclusions that the evaluation supports.

# Mechanical Vibrations (RAT-030)

**L T P: 3 1 0**

## Course Objective

The course will enable the students to:

- Formulate mathematical models of the real-world's vibration problems using Newton's second law or energy principles.
- Be familiarize with the sources of vibration and concept of noise.
- Solve the complete solution of the modeled vibration problems
- Acquire understanding of vibration solution and correlating that with various characteristic parameters of the actual vibrating system.
- Make design modifications to the existing vibrating system to reduce the vibration and noise and improve the life of the mechanical component.

## Particulars

**Unit 1** **(8 Hrs)**

**Introduction:** Periodic motion, harmonic motion, superposition of simple harmonic motions, beats, Fourier analysis; Single Degree Freedom System: Free vibration, Natural frequency, Equivalent Systems, Energy method for determining natural frequency, Response to an initial disturbance; Torsional vibrations, Damped vibrations. Damping models – Structural, Coulomb and Viscous damping, Vibrations of system with viscous damping, Logarithmic decrement, Viscous dampers.

**Unit 2** **(8 Hrs)**

**Forced Vibrations:** Single Degree Freedom: Forced vibration, Harmonic Excitation with viscous damping, Steady state vibrations; Forced vibrations with rotating and reciprocating unbalance, Support excitation, vibration isolation, Transmissibility, Vibration measuring instruments- Displacement, Velocity, Acceleration and Frequency measuring instrument.

**Unit 3** **(8 Hrs)**

**Two Degree Freedom Systems:** Introduction, Principal modes, Double pendulum, Torsional system with damping. Coupled System, Undamped dynamic, vibration absorbers, Centrifugal pendulum absorber, Dry friction damper, Untuned viscous damper.

**Unit 4** **(8 Hrs)**

**Multi Degree Freedom System:** Exact Analysis Undamped free and forced vibrations of multidegree system; Influence numbers, Reciprocal Theorem, Torsional vibration of multi rotor system, Vibration of geared system. Principal coordinates Continuous systems- Longitudinal vibration of bars, Torsional vibrations of Circular shafts, Lateral vibration of beams.

**Unit 5** **(8 Hrs)**

**Numerical Analysis:** Rayleigh's, Dunkerley's, Holzer's and Stodola's methods, Rayleigh – Ritz method. Critical Speed of Shafts: Shafts with one disc with and without damping, multi-disc shafts, Secondary critical speed.

**Reference Books:**

1. Rao. S.S, "Mechanical Vibrations", 5th Edition, Pearson Education Inc. Delhi 2009.
2. Kewelpujara, "Vibration and noise for engineers", Dhanpatrai & Sons, 2009.
3. Rao. J.S and Gupta. K, "Introductory course on theory and practice of mechanical vibrations", 2nd Edition, New Age International, New Delhi, 2014.
4. Ambekar. A.G, "Mechanical Vibrations and Noise engineering", PHI New Delhi, 2015.
5. Thomson.W.T, "Theory of Vibration and its Applications", 5th Edition, Prentice Hall, New Delhi, 2001.

**Course Outcomes**

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

**CO1**: Ability to analyze natural frequency.

**CO2**: Ability to understand single degree of free and forced vibration systems.

**CO3**: Capability to analyze different types of absorbers.

**CO4**: Ability to understand the multi degree of free and forced vibration system.

**CO5**: Understand about critical speed.

## Automation in Engineering (RAT-031)

**L T P: 3 1 0**

**Course Objective**

To familiarize with the components of computer aided manufacturing and computer aided design.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction to Automation:** Introduction to automation, why automation is needed, Current trends in automation, Industrial control systems in process, discrete manufacturing industries, introduction to robotics, classification of robots and characteristics, introduction to CAD, CAM and CIM.

**Unit 2** **(8 Hrs)**

**Types of Automation:** Rigid automation – part handling – job orienting and feeding devices, transfer mechanism and feed cut of components in machine tools, Automated Material handling.

Flexible automation – computer control of machine tools and machining centers. NC and NC part programming. CNC adaptive control, Assembly Flexible fixturing.

**Unit 3** **(8 Hrs)**

**Manufacturing Support Systems:** Fundamentals of CAD, hardware in CAD- Computer Graphics Software and Data Base, Geometric modeling for downstream applications and analysis methods.

**Computer Aided Manufacturing:** CNC technology, PLC, Micro-controller, CNC – Adaptive control.

**Unit 4** **(8 Hrs)**

**Low Cost Automation:** Mechanical and Electro mechanical systems, design aspect of hydraulic systems like pumps, valves, filters, reservoirs, accumulators, actuators, intensifiers etc. and their selection. Pneumatic fundamentals – control elements, position and pressure sensing – logic circuits, switching circuits.

Practical case studies on hydraulic circuit design and performance analysis.

**Unit 5** **(8 Hrs)**

**Modeling and Simulation:** Introduction to modeling and simulation, need for system modeling, Product design, process route modeling, Modern tools- Fuzzy decision making and Artificial Neural Networks in manufacturing automation. Case studies and industrial applications of manufacturing systems.

**Reference Books:**

1. Mikell P. Groover, Automation, Production Systems and Computer integrated Manufacturing, Prentice Hall.
2. SeropeKalpaljian and Steven R Schmid, Manufacturing- Engineering and Technology, 7th edition, Pearson.
3. N. Viswanandham, Y. Narhari "Performance Modeling of Automated Manufacturing Systems" Prentice-Hall.
4. YoramKoren, Computer control of manufacturing system, 1st edition.
5. Ibrahim Zeid, CAD/CAM: Theory & Practice, 2nd edition.

**Course Outcomes**

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

**CO1:** Understand the importance of automation in the field of machine tool-based manufacturing.

**CO2:** Acquire the knowledge of various types of automation.

**CO3:** Understand the components of manufacturing support systems.

**CO4:** Know about the low-cost automation system and their implementation.

**CO5:** Understand the basics of product design and the role of manufacturing automation.

## Design of Jigs, Fixture and Press Tools (RAT-032)

**L T P: 3 1 0**

**Course Objective**

To understand the functions and design principles of Jigs, fixtures and press tools and to gain proficiency in the development of required views of the final design.

**Particulars**

**Unit 1** **(8 Hrs)**

**Purpose Types and Functions of Jigs and Fixtures:** Tool design objectives - Production devices - Inspection devices - Materials used in Jigs and Fixtures – Types of Jigs - Types of Fixtures-Mechanical actuation-pneumatic and hydraulic actuation-Analysis of clamping force-Tolerance and error analysis.

**Unit 2** **(8 Hrs)**

**Jigs:** Drill bushes –different types of jigs-plate latch, channel, box, post, angle plate, angular post, turnover, pot jigs-Automatic drill jigs-Rack and pinion operated. Air operated Jigs components. Design and development of Jigs for given components.

**Unit 3** **(8 Hrs)**

**Fixtures:** General principles of boring, lathe, milling and broaching fixtures- Grinding, planning and shaping fixtures, assembly, Inspection and welding fixtures- Modular fixtures. Design and development of fixtures for given component.

**Unit 4** **(8 Hrs)**

**Press Working Terminologies and Elements of Dies and Strip Lay Out:** Press working Terminology-Presses and press Accessories-Computation of capacities and tonnage requirements. Elements of progressive combination and compound dies: Die block-die shoe. Bolster plate-punch plate-punch holder-guide pins and bushes – strippers –knockouts-stops –pilots-Selection f standard die sets strip lay out-strip lay out.

**Unit 5** **(8 Hrs)**

**Design and Development of Dies:** Design and development of progressive and compound dies for Blanking and piercing operations. Bending dies – development of bending dies-forming and drawing dies-Development of drawing dies. Design considerations in forging, extrusion, casting and plastic dies.

**Reference Books:**


1. Joshi, P.H. Jigs and Fixtures, Second Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2010.
2. Joshi P.H Press tools – Design and Construction, wheels publishing, 1996
3. ASTME Fundamentals of Tool Design Prentice Hall of India.
4. Design Data Hand Book, PSG College of Technology, Coimbatore.
5. Donaldson, Lecain and Goold Tool Design, 5th Edition, Tata McGraw Hill, 2017.
6. Hoffman Jigs and Fixture Design, Thomson Delmar Learning, Singapore, 2004.
7. Kempster, Jigs and Fixture Design, Third Edition, Hoddes and Stoughton, 1974.
8. Venkataraman. K., Design of Jigs Fixtures and Press Tools, Tata McGraw Hill, New Delhi, 2005.


**Course Outcomes**

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

**CO1:** Summarize the different methods of Locating Jigs and Fixtures and Clamping principles

**CO2:** Design and develop jigs and fixtures for given component

**CO3:** Discuss the press working terminologies and elements of cutting dies

**CO4:** Distinguish between Bending and Drawing dies.

**CO5:** Discuss the different types of forming techniques

# Medical Robots (RAT-033)

**L T P: 3 1 0**

## Course Objective

The course will enable the students to:

- To understand how medical robots are used in computer integrated minimally invasive surgery.
- To understand the diverse applications of robotics in surgery.
- To understand the importance of robotics in Rehabilitation and medical care.
- To understand the methodologies for design of medical robots.

## Particulars

**Unit 1** **(8 Hrs)**

Types of medical robots: Navigation, Motion Replication, Imaging, Rehabilitation and Prosthetics, State of art of robotics in the field of healthcare; Localization and Tracking: Position sensors requirements, Tracking, Mechanical linkages, Optical, Sound-based, Electromagnetic, Impedance-based, In-bore MRI tracking, Video matching, Fiber optic tracking systems, Hybrid systems.

**Unit 2** **(8 Hrs)**

Applications of Surgical Robotics: Radiosurgery, Orthopaedic Surgery, Urologic Surgery and Robotic Imaging, Cardiac Surgery, Neurosurgery, ENT surgery; Robots in rehabilitation: Rehabilitation for Limbs, Brain-Machine Interfaces, Steerable Needles.

**Unit 3** **(8 Hrs)**

Robots in Medical Care: Assistive robots – types of assistive robots – case studies; Design of Medical Robots: Characterization of gestures to the design of robots, Design methodologies- Technological choices – Security

## Reference Books:

1. Paula Gomes, Medical robotics: Minimally invasive surgery, Woodhead Publishing Limited, 2012.
2. AchimSchweikard and Floris Ernst, Medical Robotics, Springer, 2015
3. Jocelyne Troccaz, Medical Robotics, John Wiley & Sons, 2012.
4. Pedro Encarnação and Albert M. Cook, Robotic Assistive Technologies: Principles and Practice, CRC Press, 2017.
5. Roberto Colombo and Vittorio Sanguineti, Rehabilitation Robotics: Technology and Application, Academic Press, 2018

**Course Outcomes**

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

**CO1:** Understand how medical robots are used in computer integrated minimally invasive surgery.

**CO2:** Understand the diverse applications of robotics in surgery.

**CO3:** Understand the application of robots in rehabilitation and medical care.

**CO4:** Understand the methodologies for design of medical robots.

## DEPARTMENTAL ELECTIVE-5

## Intelligent Control Systems (RET-034)

**L T P: 3 1 0**

**Course Objective**

The course will enable the students to:

- To equip them with knowledge of various soft computing tools.
- Impart knowledge regarding the theory and application of fuzzy logic controller design.
- Understand of various nonlinear controller strategies.

**Particulars**

**Unit 1** **(8 Hrs)**

Basic Concepts for Intelligent Systems - Artificial Neural Networks - Perceptral Networks - Radial Basis Function Networks - Back-propagation Networks and Recurrent Networks - System Identification Using Neural Networks - Fuzzy logic - Knowledge Representation - Fuzzy Sets - Fuzzy Rules and Reasoning - Fuzzy Logic Control - Mamdani Model - Takagi-Sugeno Model - System Identification using T-S Fuzzy Models.

**Unit 2** **(8 Hrs)**

Nonlinear Control - Nonlinear State-space Model - Lyapunov Stability Theory - Lyapunov's Indirect Method - Nonlinear Control Strategies Direct Adaptive Control Using Neural Networks - Direct Adaptive Control - SISO and MIMO Systems - Back-stepping Control.

**Unit 3** **(8 Hrs)**

Fuzzy Model Based Control - T-S Fuzzy model - Linear Matrix Inequality (LMI) Technique - Fixed Gain state Feedback Controller Design Technique - Variable Gain Controller Design using Single Linear Nominal Plant and each

**Reference Books:**

1. Behera L., Kar I., “Intelligent Systems and Control: Principles and Applications”, Oxford University Press, 2009.
2. Gopal M., “Digital Control and State Variable Methods”, Tata McGraw Hill, third Edition, 2008.
3. Zi-Xing C., “Intelligent Control: Principles, Techniques and Applications”, World Scientific Publishing Co. Pvt. Ltd., 1997.

4. Jang J. S. R., Sun C. T., Mizutzni E., “Neuro-Fuzzy and Soft Computing”, Prentice Hall India Private Limited, 2002.

**Course Outcomes**

At the end of course, the student will able to:

**CO1:** Explain the principles of soft computing tools like neural networks and fuzzy logic

**CO2:** Apply neural networks and fuzzy logic for system identification

**CO3:** Develop understanding of various non-linear control strategies

**CO4:** Design fuzzy logic controllers

# 3D Printing and Rapid Prototyping (RAT-035)

**L T P: 3 1 0**

**Course Objective**

The course is designed to impart knowledge and skills related to 3D printing technologies, selection of material and equipment and develop a product using this technique in Industry 4.0 environment.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction:** Historical developments, Fundamentals of RP Systems and its Classification, Rapid prototyping process chains, 3D modeling and mesh generation, Data conversion and transmission.

**Unit 2** **(8 Hrs)**

**RP Systems:** Liquid polymer based rapid prototyping systems, Teijin Seikis' solid form and other similar commercial RP systems, Solid input materials based rapid prototyping systems, laminated object manufacturing (LOM) and fused deposition modelling systems etc., Power based rapid prototyping systems, selective Laser sintering, Soligen Diren's shell production casting (DSPC), Fraunhofer's multiphase jet solidification (MJS) and MIT's 3D printing (3DP) etc.

**Unit 3** **(8 Hrs)**

**RP Database:** Rapid prototyping data formats, STL format, STL file problems, STL file repair, Network based operations, Digital inspection, Data warehousing and learning from process data.

**Unit 4** **(6 Hrs)**

**RP Applications:** Development of dies for moulding, RP applications in developing prototypes of products, application in medical fields,

**Unit 5** **(6 Hrs)**

Development of bone replacements and tissues, etc, RP materials and their biological acceptability.

**Reference Books:**

1. Rapid Prototyping of Digital Systems: A Tutorial Approach by Hamblen James O Kluwer Aca
2. Rapid Prototyping: Principles and Applications by Kai Chua Chee World Scie
3. Rapid System Prototyping withFpgas: Accelerating the Design Process by R C Cofer Newnes

**4.** Rapid Prototyping of Digital Systems by James O Hamblen Springer

**Course Outcomes**

At the end of course, the student will able to:

**CO1**: Gain basic knowledge of rapid prototyping and 3D modelling.

**CO2**: Understand and learn RP systems.

**CO3**: Understand RP database.

**CO4**: Apply RP systems and database.

**CO5**: Develop of bone replacements and tissues.

## Total Quality Management and Reliability Engineering (RAT-036)

**L T P: 3 1 0**

**Course Objective**

To provide knowledge and understanding about the Total Quality Management (TQM), its concepts, tools and techniques, and to understand the reliability of different systems.

**Particulars**

**Unit 1** **(8 Hrs)**

**Basic Concepts:** Introduction, need for quality, evolution of quality; Definitions of quality, product quality and service quality; Basic concepts of TQM, TQM framework, contributions of Deming, Juran and Crosby. Barriers to TQM; Quality statements, customer focus, customer orientation & satisfaction, customer complaints, customer retention; costs to quality.

**Unit 2** **(8 Hrs)**

**TQM Principles:** TQM principles; leadership, strategic quality planning; Quality councils- employee involvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCE cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection.

**Unit 3** **(8 Hrs)**

**TQM Basic Tools and Techniques:** The seven traditional tools of quality; New management tools; Six sigma- concepts, methodology, applications to manufacturing, service sector including IT, Bench marking process; FMEA- stages, types.TQM tools and techniques, control charts, process capability, concepts of six sigma, Quality Function Development (QFD), Taguchi quality loss function; TPM- concepts, improvement needs, performance measures.

**Unit 4** **(8 Hrs)**

**Quality Systems:** Quality systems, need for ISO 9000, ISO 9001-9008; Quality system- elements, documentation, Quality auditing, QS 9000, ISO 14000- concepts, requirements and benefits; TQM implementation in manufacturing and service sectors.

**Unit 5** **(8 Hrs)**

**Reliability:** Introduction and definition about reliability, Probabilistic nature of failures, Mean failure rate and Mean time between failures (MTBF) of component/system: Problems, Hazard rate and Hazard models: Problems,

Weibull model for reliability of components/systems, Reliability of components in Series configuration, Reliability of components in Parallel configuration, Redundant and Mixed configurations, System reliability improvement, Case studies in reliability of system.

**Reference Books:**


1. Joel E. Ross, Susan Perry, "Total Quality Management: Text, Cases, and Readings", CRC Press, 3rd Edition, 1999.
2. Srinath, L. S., "Reliability Engineering", EastWest Press, NewDelhi,4th Edition 1995.
3. Besterfield D. H. et al., Total quality Management, 3rd ed., Pearson Education Asia, 2006.
4. Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., first Indian edition, Cengage Learning, 2012.
5. Janakiraman B. and Gopal R.K., Total Quality Management, Prentice Hall India, 2006.
6. Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India, 2006.
7. Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., first Indian edition, Cengage Learning, 2012.
8. Zeiri, "Total Quality Management for Engineers", Wood Head Publishers, 1991.
9. Poornima M charantimath, "Total Quality Management", Pearson Education, 2nd Edition, 2011.
10. Balagurusamy, E., "Reliability Engineering", Tata Mc-Graw Hill publishing Co., New Delhi,1984.


**Course Outcomes**

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

**CO1**: Gain knowledge and understanding of the philosophies which have enabled the development of organizational quality improvement programs, use of control chart for quality assessment and some parameters of quality management such as quality in design, quality in manufacturing and quality in procurement.

**CO2**: Recognize the contributions of world's leading experts on quality management and through this, develop the intellectual skills.

**CO3**: Understand the importance of process knowledge and process control and understand how staff, customers and stakeholders are part of the success of an organization.

**CO4**: Understand the scope of quality management be aware of the need to think differently in an organization and develop a glossary of items which relate to the concepts of quality.

**CO5**: Apply the concept of reliability.

## Smart Sensors (RAT-037)

**L T P: 3 1 0**

**Course Objectives**

The course will enable the students to:

- Understand various physical phenomena behind the operation of different types of sensors and micro systems.
- Design sensors with appropriate electronic interface as a complete system.
- Appreciate and understand the applications of sensors.

**Particulars**

**Unit 1** **(10 Hrs)**

Sensor Characteristics and Physical Principles of Sensing - Example of Smart Sensors in nature (Vision – Hearing–touch -and smell) - Classification and Terminology of sensors – Measurands - Physical principles of sensing -electric charges – fields - and potentials Capacitance - magnetism - Induction – resistance - Piezoelectric effect -pyroelectric effect - Hall effect - Seebeck and Peltier effects.

**Unit 2** **(12 Hrs)**

Acoustic Sensors - Magnetic Sensors and Mechanical Sensors - Acoustic waves, piezoelectric materials – Acoustic sensing, -saw sensor - Sensor applications and future trends - Magnetic sensors - effects and materials – Integrated Hall sensors – Magnetotransistors - other magnetics transistor and future trends, Mechanical sensors - piezoresistivity - Piezoresistive sensors - Capacitive sensors. Radiation Sensors Thermal Sensors and Chemical Sensors - Radiation basics - HgCdTe infrared sensors - Visible-light color sensors - high-energy photodiodes - Heat transfer - thermal structures – Thermal sensing elements - Thermal and temperature sensors - Interaction of gaseous species at semiconductor Surfaces - Catalysis - the acceleration of chemical reactions - Thin-film sensors - FET devices for gas and ion sensing.

**Unit 3** **(12 Hrs)**

Micro-and Nanotechnologies or Sensors - Fundamentals of MEMS fabrication - introduction and description of basic processes - MEMS fabrication technologies - bulk micromachining - Surface micromachining - High-aspectratio (LIGA and LIGA-Like) technology microfluidics microsystem components Microfluidics microsystem components Nanotechnology - product prospects - application trends Procedures and techniques -

the making of ultrathin films Creation of lateral nanostructures - clusters and Nano crystalline materials and principles of self-organization and Future trends.

**Reference Books:**

1. Jacob Fraden, "Handbook of Modern Sensors: Physics, Designs, and Applications", Springer; 4th ed. 2010.
2. S. M. Sze, "Semiconductor Sensors", Wiley-Interscience, 1994.
3. Gerard Meijer, "Smart sensor systems", Wiley, 2008.
4. W Gopel, J. Hesse, J. N. Zemel, "Sensors A Comprehensive Survey", Vol. 9, Wiley-VCH, 1995.

**Course Outcomes**

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

**CO1:** Explain various physical phenomena behind the operation of different types of sensors and micro systems.
**CO2:** Design sensors with appropriate electronic interface as a complete system.
**CO3:** Describe the applications of sensors.
**CO4:** Explain the process of MEMS fabrication.

# Electric Drives (RAT-038)

**L T P: 3 1 0**

**Course Objectives**

The course will enable the students to:

- Equip them with basic principles of operation of motors.
- Equip them with basic principles of operation of DC motors and drives.
- Equip them with basic principles of operation of induction motors and drives.

**Particulars**

**Unit 1** **(12 Hrs)**

Introduction to Electric Motors - Review of mathematical tools - phasor diagrams - solving ODEs - Z- transforms- Producing Rotation - Magnetic Circuits - Torque Production - Specific Loadings And Specific Output – Energy Conversion–Motional Emf - Equivalent Circuit - General Properties Of Electric Motors - Power Electronic Converters For Motor Drives - Introduction Voltage Control - Controlled Rectification - Single Phase Inversion - Inverter Switching Devices - Conventional D.C. Motors - Introduction - Torque Production - Motional E.M.F, D.C. Motor–Steady-State Characteristics - Transient Behavior – Shunt - Series and Compound Motors – Four Quadrant Operation and Regenerative Braking.

**Unit 2** **(12 Hrs)**

D.C. Motor Drives - Thyristor D.C. Drives - Control Arrangements for D.C. Drives - Chopper-Fed D.C. Motor Drives - D.C. Servo Drives - Digitally Controlled Drives - Induction Motors - The Rotating Magnetic Field - Torque Production - Influence Of Rotor Current On Flux - Stator Current-Speed Characteristics - Methods Of Starting Cage Motors - Run-Up And Stable Operating Regions - Torque–Speed Curves–Influence Of Rotor Parameters - Influence Of Supply Voltage - Generating And Braking - Speed Control - Power Factor Control and Energy Optimization - Single-Phase Induction Motors.

**Unit 1** **(10 Hrs)**

Inverter-Fed Induction Motor Drives - Torque–Speed Characteristics–Constant V/F Operation, Control Arrangements For Inverter-Fed Drives - Vector (Field-Oriented) Control, D-Q model of induction motor – Cyclo Converter Drives - Stepper motors – Synchronous - Brushless D.C. And Switched Reluctance Drives.

**Reference Books:**

1. Austin Hughes, "Electric Motors and Drives Fundamentals, Types and Applications, Newnes press", Elsevier Ltd. 3rd edition, 2006.
2. David Polka, "Motors and Drives: A Practical Technology Guide, The Instrumentation, Systems, and Automation Society", 2003.
3. Nagrath I J and Kothari D P, "Electrical Machines", Tata McGraw-Hill, Second Edition, 2000. Gopal K. Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, 2001.
4. Pillay. S.K, A "First Course on Electric Drives", Wiley Eastern Limited, Bombay, 1987.

**Course Outcomes**

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

**CO1:** Explain the basic principles of operation of motors.

**CO2:** Explain the basic principles of operation of drives.

**CO3:** Describe the construction various motors and drives.

**CO4:** Describe the working of various motors and drives.

**Project Seminar (MAP-015)**

## Course Objectives

The course should enable the students to:

- Identify and compare technical and practical issues related to the area of course specialization.
- Outline annotated bibliography of research demonstrating scholarly skills.
- Prepare a well-organized report employing elements of technical writing and critical thinking.
- Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presenting.

## Course Outcomes

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

**CO1:** Establish motivation for any topic of interest and develop a thought process for technical presentation.

**CO2:** Organize a detailed literature survey and build a document with respect to technical publications.

**CO3:** Analyze and comprehend proof-of-concept and related data.

**CO4:** Make effective presentation and improve soft skills.

**CO5:** Make use of new and recent technology (e.g. Latex) for creating technical reports

**Project Stage - II (MAP-016)**

## Course Objectives

The course should enable the students:

- To allow students to demonstrate a wide range of the skills learned during their course of study.
- To encourage multidisciplinary research through the integration learned in a number of courses.
- To allow students to develop problem solving, analysis, synthesis and evaluation skills.
- To encourage teamwork.
- To improve students' communication skills by asking them to produce both a professional report and to give an oral presentation

## Course Outcomes

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

**CO1:** Demonstrate a sound technical knowledge of their selected project topic.
**CO2:** Undertake problem identification, formulation and solution.
**CO3:** Combine the theoretical and practical concepts studied in his / her academics.
**CO4:** Communicate with engineers and the community at large in written and oral forms.
**CO5:** Demonstrate the knowledge, skills and attitudes of a professional engineer.

## Internship III/ Mini Project III (MAP-017)

### Course Objectives

The course should enable the students to:

- Create an Industrial environment and culture within the institution.
- Identify the issues and challenges of an industry.
- Prepare report on the application of emerging technologies in the selected industry.
- Learn and understand the concept of entrepreneurship.
- Inculcate innovative thinking.

### Course Outcomes:

On completion of the course, student will be able to–

**CO1:** Develop his abilities to transmit technical information clearly and test the same by delivery of Seminar based on the Mini Project or Internship.

**CO2:** Understand the importance of document design by compiling Technical Report on the Mini Project or Internship work carried out.

**CO3:** Comment and evaluate other students research questions and internship proposals.

## Disaster Management (AHT-017)

**L T P: 3 0 0**

### Course Objectives

The course should enable the students to:

- Introduce themselves to various types of natural and manmade disasters.
- Understand causes and impact of disasters.
- Understand approaches of Disaster Management.
- Build skills to respond to disaster.

### Particulars

**Unit 1** **(8 Hrs)**

**Introduction to Disasters**

Concepts, and definitions (Disaster, Hazard, Vulnerability, Resilience, Risks). Disaster Types, Trends, Causes, Consequences and Control of Disasters, Geological Disasters; Hydro-Meteorological, Biological, Technological and Manmade Disasters.

**Unit 2** **(8 Hrs)**

**Disasters: Classification, Causes, Impacts**

(Including social, economic, political, environmental, health, psychosocial, etc.)

Differential impacts-in terms of caste, class, gender, age, location, disability. Global trends in disasters urban disasters, pandemics, complex emergencies, Climate change.

**Unit 3** **(8 Hrs)**

**Approaches to Disaster Risk Reduction:**

Disaster cycle- its analysis, Phases, Culture of safety, prevention, mitigation and preparedness, community based DRR, Structural- nonstructural measures, roles and responsibilities of community, Panchayati Raj Institutions/ Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders.

**Unit 4** **(8 Hrs)**

**Inter-relationship between Disasters & Development**

Factors affecting Vulnerabilities, differential impacts, Impact of Development projects such as dams, embankments, changes in Land-use etc. Climate Change Adaptation. Relevance of indigenous knowledge, appropriate technology and local resources

**Unit 5** **(8 Hrs)**

**Disaster Risk Management in India:**

Hazard and Vulnerability profile of India. Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management Institutional arrangements (Mitigation, Response and Preparedness, DM Act and Policy, Other related policies, plans, programmes and legislation)

**Text/Reference Books:**

1. Disaster Management Guidelines, GOI-UND Disaster Risk Program (2009-2012)

2. Damon, P. Copola, (2006) Introduction to International Disaster Management, Butterworth Heineman.

3. Gupta A.K., Niar S.S and Chatterjee S. (2013) Disaster management and Risk Reduction, Role of Environmental Knowledge, Narosa Publishing House, Delhi.

4. Murthy D.B.N. (2012) Disaster Management, Deep and Deep Publication PVT. Ltd. New Delhi.

5. Modh S. (2010) Managing Natural Disasters, Mac Millan publishers India LTD.

**Course Outcomes**

At the end of the course, Student will be able to:

**CO1:** Have an exposure to disasters, their significance and types.

**CO2:** Understand the relationship between vulnerability, disasters, disaster prevention and risk reduction.

**CO3:** Understand approaches of Disaster Management.

**CO4:** Build skills within themselves to respond to disasters.

## Innovations and Problem Solving (AHT-018)

**L T P: 2 1 0**

### Prerequisite:

Basic Engineering Aptitude

**Course Objectives:** This subject aims to inculcate critical thinking abilities and application of knowledge for problem solving. It will expose the students with various simple methods and practices that are essential to development of new systems, problem formulation and problem solving in technical and non-technical fields. This course will stimulate the work environment of the modern day engineers and technologists by familiarizing them with the state-of-the art results, design and analysis tools in various disciplines, the ability to extract relevant information to formulate and solve problems arising in practice.

**Particulars**

**Unit 1** **8 Hrs**

**Introduction to Critical Design Thinking**

- Understanding critical thinking, creative thinking, and problem solving through examples.
- New ways to solve problems.

**Unit 2** **8 Hrs**

**Theory of Inventive Problem Solving**

- Examples of inventive problem solving
- Era of technical systems
- Science of inventing
- Art of inventing
- Amazing world of tasks.

**Unit 3** **8 Hrs**

**Logic and Tools for Creativity and Clarity of Thought**

- TRIZ tools for creativity and solutions
- World’s known solutions
- Fundamentals of Problem solving
- Thinking in Time and Scale
- Uncovering and solving contradictions
- Fast Thinking with ideal outcome.

**Unit 4** **8 Hrs**

**Modeling for Problem Solving**

- Moving from problem to ideal final result
- Tradeoffs and inherent contradictions
- Invisible reserves
- Law of increasing ideality
- Evaluation of solutions
- Enriching models for problem solving.

**Unit 5** **8 Hrs**

**Principles for Innovation**

- General review
- Segmentation, Separation
- Local quality, symmetry change, merging and multifunctionality
- Nested doll and weight compensation
- Preliminary counteraction, preliminary action, and beforehand compensation
- Equipotentiality, the other way around and curvature increase
- Dynamic parts, partial or excessive actions, dimensionality change, mechanical vibration
- Periodic action, continuity of useful action, and hurrying
- Blessing in disguise, feedback, and intermediary
- Self service, copying, cheap disposables, and mechanical interaction substitution
- Pneumatics and hydraulics, flexible shells and thin films, and porous materials
- Optical property changes, homogeneous, and discarding and recovering
- Parameter changes, phase transitions, and thermal expansion
- Strong oxidants, inert atmosphere, and composite materials
- How to select most suitable principle out of 40 ways to create good solutions

**References:**

1- ABC-TRIZ Introduction to Creative Design Thinking with Modern TRIZ Modeling by Michael A. Orloff
2- TRIZ And Suddenly the Inventor Appeared TRIZ, the Theory of Inventive Problem Solving by GenrichAltshuller
3- TRIZ for Engineers Enabling Inventive Problem Solving by Karen Gadd
4- Simplified TRIZ New Problem Solving Applications for Engineers and Manufacturing Professionals by Rantanen K., Domb E.
5- Simplified TRIZ New Problem Solving Applications for Engineers and Manufacturing Professionals by Rantanen K., Domb E.

**Course Outcomes:**

The course will enable students to:

**CO1:** Identify the market and value proposition.

**CO2:** Carry out rigorous and accessible formulation to problems.

**CO3:** Solutions via reducing the search space.

**CO4:** Eliminating tradeoffs to reduce dimension of optimization problems.

**CO5:** Execution through developing strategies for experiment, construction and monetization.

**CO6:** Simulate the work environment of the modern engineer or knowledge worker in general.

| B.TECH. (ROBOTICS AND AUTOMATION) SEMESTER-VIII | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sl. No. | Subject Codes | Category | Subject | Periods | | | Evaluation Scheme | | | | | Subject Total | Credit |
| | | | | | | | Sessional Exam | | | ESE | | | |
| | | | | L | T | P | CT | TA | Total | TE | PE | | |
| 1 | AHT - 016/AHT-015 | HSC | HSMC-2 /HSMC-1 | 3 | 0 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 2 | RAT-XXX | DE | Departmental Elective-6 | 3 | 0 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 3 | | OE | Open Elective-3 | 3 | 0 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 4 | | OE | Open Elective-4 | 3 | 0 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 5 | RAP-018 | DLC | Project Stage -III | 0 | 0 | 12 | | | 100 | | 200 | 300 | 6 |
| 6 | GP-08 | NC | General Proficiency | | | | | | 50 | | | | |
| | | | **Total** | **12** | **0** | **14** | | | | | | **900** | **18** |
| 7 | | | Open Elective (Optional) | 3 | 1 | 0 | 30 | 20 | 50 | 50 | | 150 | 4 |

| Departmental Elective - 6 | |
|---|---|
| RAT-039 | Modelling & Simulation |
| RAT-040 | Electronic Devices & Circuits |
| RAT-041 | Computer Vision & Image Processing |
| RAT-042 | Project Management |
| RAT-043 | New Product Design & Development |
| RAT-044 | Six Sigma |
| RAT-045 | Work Study |
| RAT-046 | Computational Methods in Engineering |

**Open Electives offered by the department in 7th and 8th Semester for other department students:**

| | | |
|---|---|---|
| Open Elective-2 | MAT-044 | Reliability and Maintenance Engineering |
| Open Elective-3 | MAT-045 | Project Management |
| Open Elective-4 | MAT-046 | Six Sigma |
| **Note: Mechanical & Automation Engineering student shall opt open electives offered by other departments** | | |

| | | |
|---|---|---|
| HSMC-1 | AHT-015 | Rural Development, Administration and Planning |
| HSMC-2 | AHT-016 | Project Management & Entrepreneurship |

# HSMC-2

## Project Management & Entrepreneurship (AHT-016)

**L T P: 3 1 0**

**Course Objectives**

The course should enable the students to:

- Understand the concepts of Project Management for planning to execution of projects.
- Understand the feasibility analysis in Project Management and network analysis tools for cost and time estimation.
- Be capable to analyze, apply and appreciate contemporary project management tools and methodologies in Indian context.
- Understand the concepts of Entrepreneurship, role of entrepreneur in economic development, steps for establishing an enterprise.

**Particulars**

**Unit 1** **(8 Hrs)**

**Entrepreneurship:**Entrepreneurship: need, scope , Entrepreneurial competencies & traits, Factors affecting entrepreneurial development, Entrepreneurial motivation (Mc Clellend's Achievement motivation theory), conceptual model of entrepreneurship , entrepreneur vs. intrapreneur; Classification of entrepreneurs; Entrepreneurial Development Programmes.

**Unit 2** **(8 Hrs)**

**Entrepreneurial Idea and Innovation**: Introduction to Innovation, Entrepreneurial Idea Generation and Identifying Business Opportunities, Management skills for Entrepreneurs and managing for Value Creation, Creating and Sustaining Enterprising Model & Organizational Effectiveness.

**Unit 3** **(8 Hrs)**

**Project Management:** Project management: meaning, scope & importance, role of project manager; project life-cycle Project appraisal: Preparation of a real time project feasibility report containing Technical appraisal,

Environmental appraisal, Market appraisal (including market survey for forecasting future demand and sales) and Managerial appraisal.

**Unit 4** **(8 Hrs)**

**Project Financing:**Project cost estimation & working capital requirements, sources of funds, capital budgeting, Risk & uncertainty in project evaluation , preparation of projected financial statements viz. Projected balance sheet, projected income statement, projected funds & cash flow statements, Preparation of detailed project report, Project finance.

**Unit 5** **(8 Hrs)**

**Social Entrepreneurship:** Social Sector Perspectives and Social Entrepreneurship, Social Entrepreneurship Opportunities and Successful Models, Social Innovations and Sustainability, Marketing Management for Social Ventures, Risk Management in Social Enterprises, Legal Framework for Social Ventures.

**Case study and presentations:** Case study of successful and failed entrepreneurs. Power point presentation on current business opportunities.

**Text Books**

1. Innovation and Entrepreneurship by Drucker, P.F.; Harperand Row.
2. Business, Entrepreneurship and Management: Rao, V.S.P.;Vikas
3. Entrepreneurship: Roy Rajeev.
4. Text Book of Project Management: Gopal Krishnan, P.and Ramamoorthy,V.E.; McMill.
5. Project Management for Engineering, Business and Technology: Nicholas, J.M., and Steyn, H.; PHI.
6. Project Management: The Managerial Process: Gray, C.F., Larson, E.W. and Desai, G.V.; MGH.

**Course Outcomes**

After completion of the course student will be able to:

**CO1:** Understand project characteristics and various stages of a project.

**CO2:** Understand the conceptual clarity about project organization and feasibility analyses – Market, Technical, Financial and Economic.

**CO3:** Analyze the learning and understand techniques for Project planning, scheduling and Execution Control.

**CO4:** Describe Entrepreneurship, Examine role of entrepreneur in economic development.

**CO5:** Describe the steps to establish an enterprise.

# HSMC-1

## Rural Development: Administration and Planning (AHT-015)

**L T P: 3 1 0**

**Course Objectives**

This course enables the students to:

- Gain knowledge on the concepts related to administration, its importance and various approaches of Development Administration.
- Gain skills on New Public Management, Public Grievances and Redressal Mechanisms, Accountability and Transparency in Administration and e-governance in the rural development sector.
- Develop their competency on the role of Bureaucracy in Rural Development.

**Particulars**

**Unit 1** **(8 Hrs)**

**Rural Planning & Development:** Concepts of Rural Development, Basic elements of rural Development, and Importance of Rural Development for creation of Sustainable Livelihoods, An overview of Policies and Programmes for Rural Development- Programmes in the agricultural sector, Programmes in the Social Security, Programmes in area of Social Sector.

**Unit 2** **(8 Hrs)**

**Rural Development Programmes:** Sriniketan experiment, Gurgaon experiment, Marthandam experiment, Baroda experiment, Firkha development scheme, Etawapilot project, Nilokheri experiment, approaches to rural community development: Tagore, Gandhi etc.

**Unit 3** **(8 Hrs)**

**Panchayati Raj & Rural Administration:**Administrative Structure: bureaucracy, structure of administration; Panchayati Raj Institutions Emergence and Growth of Panchayati Raj Institutions in India; People and Panchayati Raj; Financial Organizations in Panchayati Raj Institutions, Structure of rural finance, Government & Non-Government Organizations / Community Based Organizations, Concept of Self help group.

**Unit 4** **(8 Hrs)**

**Human Resource Development in Rural Sector:** Need for Human Resource Development, Elements of Human Resource Development in Rural Sector Dimensions of HRD for rural development-Health, Education, Energy, Skill Development, Training, Nutritional Status access to basic amenities – Population composition.

**Unit 5** **(8 Hrs)**

**Rural Industrialization and Entrepreneurship:** Concept of Rural Industrialization, Gandhian approach to Rural Industrialization, Appropriate Technology for Rural Industries, Entrepreneurship and Rural Industrialization- Problems and diagnosis of Rural Entrepreneurship in India, with special reference to Women Entrepreneurship; Development of Small Entrepreneurs in India, need for and scope of entrepreneurship in Rural area.

## Text Books/References:

1. Corporate Social Responsibility: An Ethical Approach - Mark S. Schwartz.

2. Katar Singh: Rural Development in India – Theory History and Policy.

3. Todaro M.P. Economic Development in III World war.

4. Arora R.C – Integrated Rural Development in India.

5. Dhandekar V.M and Rath N poverty in India.

6. A.N.Agarwal and Kundana Lal: Rural Economy of India.

7. B.K.Prasad: Rural Development-Sarup & Son's Publications.

**Course Outcomes**

After completion of the course student will be able to:

CO1: Understand the definitions, concepts and components of Rural Development.

CO2: Students will know the importance, structure, significance, resources of Indian rural economy.

CO3: Students will have a clear idea about the area development programmes and its impact.
CO4: Students will be able to acquire knowledge about rural entrepreneurship.

CO5: Students will be able to understand about the using of different methods for human resource planning.

## DEPARTMENTAL ELECTIVE - 6

## Modelling and Simulation (RAT-039)

**L T P: 3 1 0**

**Course Objective**

On completion of this course, the students are expected to gain knowledge about modelling and analysis of various systems calculations.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction to Modelling**: Concept of system, continuous and discrete systems; Types of models and simulation; Discrete event simulation: Time advance mechanisms, components and organization of simulation model, steps in simulation study.

**Unit 2** **(8 Hrs)**

**Statistical Models in Simulation:** Discrete, continuous, Poisson and empirical distributions, output data analysis for a single system, comparing alternative system configurations, statistical procedures for comparing real world observations with simulation output data, generation of arriving processes, verification and validation of simulation models.

**Unit 3** **(8 Hrs)**

**Stochastic Simulation:** Random number generation: Properties of random numbers, techniques of generating random numbers, generation of random variates, Monte Carlo simulation and its applications in queuing models and inventory models.

**Unit 4** **(8 Hrs)**

**Simulation of Manufacturing and Material Handling Systems:** Models of manufacturing systems, models of material handling systems, goals and performance measures; Issues in manufacturing and material handling simulation: Modelling downtime failures, trace driven models.

**Unit 5** **(8 Hrs)**

**Case Studies on Simulation Packages:** Simulation of queuing system (bank/job shop), simulation of manufacturing and material handling systems.

**Reference Books:**

1. Banks, J., Nelson, B.L., Carson, J. S., and Nicol, D., "Discrete Event System Simulation", Pearson Education.
2. Law, A.M., and Kelton, W.D., "Simulation Modeling and Analysis", McGraw-Hill.
3. Schwarzenbach, J., and Gill, K.F., "System Modeling and Control", Butterworth-Heinemann.
4. Carrie, A., "Simulation of Manufacturing Systems", John Wiley & Sons.
5. Viswanadham, N., and Narahari, Y., "Performance Modeling of Automated Manufacturing System", Prentice-Hall of India.

**Course Outcomes**

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

**CO1**: Define basic concepts in modelling and simulation (M&S) and to classify various simulation models and give practical examples for each category.
**CO2**: Construct a model for a given set of data and motivate its validity.
**CO3**: Generate and test random number variates and apply them to develop simulation models.
**CO4**: Analyze output data produced by a model and test validity of the model.
**CO5**: Explain parallel and distributed simulation methods.

## Electron Devices and Circuits (RAT-040)

**L T P: 3 1 0**

### Course Objectives

- Understand the structure of basic electronic devices.
- Be exposed to active and passive circuit elements.
- Familiarize the operation and applications of transistor like BJT and FET.
- Explore the characteristics of amplifier gain and frequency response.
- Learn the required functionality of positive and negative feedback systems.

### Particulars

**Unit 1** **(8 Hrs)**

PN junction diode –structure, operation and V-I characteristics, diffusion and transition capacitance - Rectifiers – Half Wave and Full Wave Rectifier, – Display devices- LED, Laser diodes, Zener diodecharacteristics- Zener Reverse characteristics – Zener as regulator.

**Unit 2** **(8 Hrs)**

BJT, JFET, MOSFET- structure, operation, characteristics and Biasing UJT, Thyristors and IGBT - Structure and characteristics.

**Unit 3** **(8 Hrs)**

BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response – MOSFET small signal model– Analysis of CS and Source follower – Gain and frequency response- High frequency analysis.

**Unit 4** **(8 Hrs)**

BIMOS cascade amplifier, Differential amplifier – Common mode and Difference mode analysis – FETinput stages – Single tuned amplifiers – Gain and frequency response – Neutralization methods,power amplifiers – Types (Qualitative analysis).

**Unit 5** **(8 Hrs)**

Advantages of negative feedback – voltage / current, series, Shunt feedback –positive feedback – Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.

**Text Books:**

1. David A. Bell, “Electronic devices and circuits”, Oxford University higher education, 5th edition 2008.
2. Sedra and smith, “Microelectronic circuits”,7th Ed., Oxford University Press

**References:**

1. Balbir Kumar, Shail.B.Jain, “Electronic devices and circuits” PHI learning private limited, 2nd edition2014.
2. Thomas L.Floyd, “Electronic devices” Conventional current version, Pearson prentice hall, 10th Edition, 2017.
3. Donald A Neamen, “Electronic Circuit Analysis and Design” Tata McGraw Hill, 3rd Edition, 2003.
4. Robert L.Boylestad, “Electronic devices and circuit theory”, 2002.
5. Robert B. Northrop, “Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation”, CRC Press, 2004.

**Course Outcomes**

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

**CO1:** Explain the structure and working operation of basic electronic devices.

**CO2:** Able to identify and differentiate both active and passive elements

**CO3:** Analyze the characteristics of different electronic devices such as diodes and transistors

**CO4:** Choose and adapt the required components to construct an amplifier circuit.

**CO5:** Employ the acquired knowledge in design and analysis of oscillators

## Computer Vision and Image Processing (RAT-041)

**L T P: 3 1 0**

### Course Objective

The objective of this course is to provide a comprehensive understanding of Computer Vision and Image Processing concepts, as well as the fundamental principles of Machine Learning as applied to visual data. The course is designed to equip students with the knowledge and skills necessary to analyze, manipulate, and interpret images and video data using both traditional image processing techniques and modern machine learning approaches.

### Particulars

**Unit 1** **(8 Hrs)**

Introduction to Computer Vision and Basic Concepts of Image Formation: Introduction and Goals of Computer Vision and Image Processing, Image Formation Concepts; Fundamental Concepts of Image Formation: Radiometry, Geometric Transformations, Geometric Camera Models, Camera Calibration, Image Formation in a Stereo Vision Setup, Image Reconstruction from a Series of Projections.

**Unit 2** **(8 Hrs)**

Image Processing Concepts: Image Transforms, Image Enhancement, Image Filtering, Colour Image Processing, Image Segmentation; Image Descriptors and Features: Texture Descriptors, Colour Features, Edges/Boundaries, Object Boundary and Shape Representations, Interest or Corner Point Detectors, Histogram of Oriented Gradients, Scale Invariant Feature Transform, Saliency.

**Unit 3** **(8 Hrs)**

Fundamentals of Machine Learning: Linear Regression, Basic Concepts of Decision Functions, Elementary Statistical Decision Theory, Parameter Estimation, Clustering for Knowledge Representation, Dimensionality Reduction, Linear Discriminant Analysis.

**Unit 4** **(8 Hrs)**

Applications of Computer Vision: Artificial Neural Network for Pattern Classification, Convolutional Neural Networks, Autoencoder, Machine Learning Algorithms and their Applications in Image Segmentation, Gesture Recognition, Object recognition, template matching, classification; Object detection and tracking: background modeling, kernel-based tracking, particle filters.

**Reference Books:**

1. David A. Forsyth and Jean Ponce, Computer Vision: A Modern Approach, 2nd Edition, Pearson Education India, 2015
2. Manas Kamal Bhuyan, Computer Vision and Image Processing - Fundamentals and Applications, CRC Press, 2020
3. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2011.
4. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, 4th Edition, Pearson, 2018

**Course Outcomes**

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

**CO1:** Understand various methods for digital image processing and analysis and relate or apply them to different applications.
**CO2:** Understand various algorithms for vision related tasks and apply them to solve practical problems.
**CO3:** Carry out in-depth analysis of the digital image data with different image data models, pattern recognition algorithms and learning theory.
**CO4:** Implement various image processing and machine learning algorithms.

## Project Management (RAT-042)

**L T P: 3 1 0**

**Course Objectives:**

The course will enable the students to:

- Gain an understanding about the basics of project management.
- Learn the implementation of various project management concepts.
- Gain knowledge of procurement.
- Learn to implement various project controls.
- Write and complete different types of projects.

### Particulars

**Unit 1** **(8 Hrs)**

**Introduction:** Characteristics of a project types of projects, Project Management Body of Knowledge (PMBOK), role of project manager and his qualities, project organization and benefits, idea generation, needs of society, import substitution, project lifecycle, project charter, project sponsor.

**Project Planning**: Customer needs, stakeholder concept, project scope, feasibility study and report, baseline plan, SWOT analysis, project organization structure and hierarchy, project teams, formation, attitude and aptitude.

**Unit 2** **(8 Hrs)**

**Structure:** Project selection methods, breakeven analysis, DCF methods, project implementation, estimation, cost, price, value, scheduling, bar charts, network diagrams, PERT and CPM, schedule crashing, simple introduction to risk management, probability in project management, decision trees.

**Unit 3** **(8 Hrs)**

**Procurement:** Vendor selection methods, JIT, supply chains, quality, quality circles, quality control and quality assurance, cause and effect analysis, ISO and concepts of total quality management and six sigma, resource planning and allocation, availability and constraints of resources, resource leveling and crashing.

**Unit 4** **(8 Hrs)**

**Project Control**: Project scope, project change request, and control of schedule, resources, cost and quality, project communications, channels, means, meetings, project reports, project audits Project evaluation, project close-out reports, guidelines, audit reports, maintenance and shutdown projects, plant turn- around and brief introduction to replacement analysis.

**Unit 5** **(8 Hrs)**

**Projects:** Contour maps, sitemaps, plant layout, suitability of project site, preparation of site, selection and leasing of construction equipment special considerations in selection and location of projects, safety, health, human and environment al factors, project finance, international projects, joint ventures, collaborations, impact of culture, implementation, and handing over of projects.

**Text Book:**

Kamarajuramakrishna, "Essentials of Project Management", PHI Learning, New Delhi, 2010.

**Reference Books:**

1. Prasanna Chandra, "Projects - Planning, Analysis, Selection, Implementation and Review", Tata Mcgraw-Hill, New Delhi, 2010.

2. Chitkara, "Construction Project Management", Tata Mcgraw- Hill, New Delhi.

3.Harold Kerzner, "Project Management", Wiley, New York.

**Course Outcomes:**

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

**CO1:** Explain the basics of project management.

**CO2:** Implement the project management concepts.

**CO3:** Apply project procurement rules.

**CO4**: Implement various project controls to real projects.

**CO5:** Prepare complete project reports.

# New Product Design and Development (RAT-043)

**L T P: 3 1 0**

**Course Objectives:**

The course will enable the students to:

- Gain competence with a set of tools and methods for product design and development.
- Gain confidence in their abilities to create a new product.
- Gain awareness of the role of multiple functions in creating a new product (e.g. marketing, finance, industrial design, engineering, production).
- Acquire ability to coordinate multiple, interdisciplinary tasks in order to achieve a common objective and enhance team-working skills.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction:** Characteristics of successful product development, Design and development of products, duration and cost of product development, the challenges of product development. Development Processes and Organizations, the front-end process, adopting the generic product development process, the AMF development process, product development organizations, the AMF organization.

**Unit 2** **(8 Hrs)**

**Product Planning:** The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process.

**Identifying Customer Needs:** Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process.

**Unit 3** **(8 Hrs)**

**Product Specifications:** What are specifications, when are specifications established, establishing target specifications, setting the final specifications.

**Concept Generation:** The activity of concept generation, clarify the problem, search externally, search internally, explore systematically, reflect on the results and the process. Concept Selection, Overview of methodology, concept screening, and concept scoring.

**Unit 4** **(8 Hrs)**

**Concept Testing:** Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process.

**Industrial Design:** Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process and assessing the quality of industrial design.

**Unit 5** **(8 Hrs)**

**Design for Manufacturing:** Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors. Prototyping, Prototyping basics, principles of prototyping, technologies, planning for prototypes.

**Reference Books:**

1. Product Design and Development - Karl.T.Ulrich, Steven D Eppinger - Irwin Mc-GrawHill - 2000.

2. Product Design and Manufacturing - A C Chitale and R C Gupta, PH1, - 3rd Edition, 2003.

3. New Product Development - Timjones. Butterworth Heinmann - Oxford. UCI -1997

4. Product Design for Manufacture and Assembly – Geoffery Boothroyd, Peter Dewhurst and Winston Knight – 2002

**Course Outcomes**

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

**CO1:** Understand the product design and development process.

**CO2:** Apply creative thinking skills for idea generation.

**CO3:** Translate conceptual ideas into products.

**CO4:** Present ideas using various types of model.

# Six Sigma (RAT-044)

**L T P: 3 1 0**

**Course Objectives**

The course will enable the students to:

- Get aware about the quality perception and learn about descriptive statistics methods.
- Learn about basics of six sigma.
- Learn about the different methodologies and implementation of six sigma.
- Learn about different six sigma tools.
- Learn about software's used with six sigma.

**Particulars**

**Unit 1** **(8 Hrs)**

**Quality Perception:** Quality in Manufacturing, Quality in Service Sector; Differences between Conventional and Six Sigma concept of quality; Six Sigma success stories. Statistical foundation and methods of quality improvement.

**Descriptive statistics:** Data Type, Mean, Median, Mode, Range, Variation, Standard Deviation, Skewness, Kurtosis.

**Probability Distribution:** Normal, Binomial, Poisson Distribution.

**Unit 2** **(8 Hrs)**

**Basics of Six Sigma:** Concept of Six Sigma, Defects, DPMO, DPU, Attacks on X'S, Customer focus, Six Sigma for manufacturing, Six Sigma for service. Z score, Understanding Six Sigma organization, Leadership council, Project sponsors and champions, Master Black Belt, Black Belt, Green Belts.

**Unit 3** **(8 Hrs)**

Methodology of Six Sigma, DMAIC, DFSS, Models of Implementation of Six Sigma, Selection of Six Sigma Projects.

**Unit 4** **(8 Hrs)**

Six Sigma Tools: Project Charter, Process mapping, Measurement system analysis, Hypothesis Testing, Quality Function deployment, Failure mode effect analysis, Design of Experiments.

**Unit 5** **(8 Hrs)**

Sustenance of Six Sigma, Communication plan, Company culture, Reinforcement and control, Introduction to softwares for Six Sigma, Understanding Minitab, Graphical analysis of Minitab plots.

**Reference Books:**


1. Six Sigma: SPC and TQM in manufacturing and service, Geoff Tennant, Gower Publishing Co.
2. Six Sigma for managers, Greg Brue, TMH
3. What is Six Sigma, Pete Pande, TMH
4. The Six Sigma Way, Peter S. Pande, TMH Team Field book
5. The Six Sigma way, Peter S. Pande, TMH


**Course Outcomes**

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

**CO1**: Understand quality perception and learn about descriptive statistics methods.

**CO2**: Learn basics of six sigma.

**CO3**: Learn about the different methodologies of six sigma.

**CO4**: Apply different six sigma tools.

**CO5**: Learn software's used with six sigma.

**Work Study (RAT-045)**

**L T P: 3 1 0**

**Course Objectives:**

The course will enable the students to:

- Gain knowledge and understanding about work-study and productivity concepts.
- Get exposed with the areas of application of Work Study in Industry.
- Gain knowledge about method study and work place design etc.
- Gain knowledge about work measurement and Time study concepts.
- Gain knowledge about incentives and training methods.

## Particulars

**Unit 1** **(8 Hrs)**

Work Study - Definition, objective and scope of method study, reasons for low productivity, methods to improve productivity, work-study and productivity.

**Unit 2** **(8 Hrs)**

Areas of Application of Work Study in Industry; Method Study and Work Measurements and their Inter-Relationship, Reaction of Management and Labour to Work Study, Role of Work Study in Improving Plant Productivity and Safety.

**Unit 3** **(8 Hrs)**

Method Study – Definition, Objectives and Procedure for Methods Analysis, Select, Record, Examine, Develop, Define, Install and Maintain; Recording Techniques, Micro Motion and Macro-Motion Study, Principles of Motion Economy, Normal Work Areas and Work Place Design.

**Unit 4** **(8 Hrs)**

Work Measurement - Definition, various techniques of work-measurement work-sampling, stopwatch time study & its procedure, Job selection, Equipment and forms used for time study, rating, methods of rating, allowances and their types, standard time, numerical problems, predetermined - time standards and standard data techniques.

**Unit 5** **(8 Hrs)**

Incentive - Meaning, objectives of an incentive plan, various types of incentive plans, Training and development Objectives, Training methods

**Reference Books:**

1. Barnes Ralph M., "Motion & Time study: Design and Measurement of Work", Wiley Text Books, 2001.
2. Marvin E, Mundel & David L, "Motion & Time Study: Improving Productivity", Pearson Education, 2000.
3. Benjamin E Niebel and Freivalds Andris, "Methods Standards & Work Design", Mc Graw Hill, 1997.
4. International Labour organization, "Work-study", Oxford and IBH publishing company Pvt. Ltd., N.Delhi, 2001.
5. Sanders Mark S and McCormick Ernert J, "Human Factors in Engineering and Design", McGraw-Hill Inc., 1993

**Course Outcomes:**

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

**CO1:** Explain the basics of work study and productivity.

**CO2:** Implement work study concepts.

**CO3:** Explain and implement method study and work place design concepts.

**CO4:** Explain and implement work measurement and Time study concepts.

**CO5:** Explain different incentives and training methods.

## Computational Methods in Engineering (RAT-046)

**L T P: 3 1 0**

### Course Objective

The objective of this course is to give an overview of computational techniques of interest to process engineer. It introduces the numerical methods to solve various kinds of equation that students encounter in the field of engineering.

### Particulars

**Unit 1**

**Introduction:** Motivation and applications, Computation and error analysis, Linear systems and equations-matrix representation, Cramer's rule, Gauss Elimination, matrix inversion, LU decomposition, iterative methods, relaxation methods, Eigen values – their physical interpretation.

**Unit 2**

**Conservation Laws and Model Equations:** Conservation Laws, Euler Equations, Navier-Strokes Equations, linear convection and diffusion equation, Linear Hyperbolic systems, Differential form and solution in wave space.

**Unit 3**

**Numerical Approximation Methods:** Finite Difference Approximations: Space derivative approximations, finite difference operators, construction of differencing schemes of any order, Fourier Error analysis.

**Finite Element Approximations**: Approximation of Elliptic problems, Piece wise Polynomial Approximation, Evolution Problems

**Finite Volume Methods:** Model equation in integral form, multidimensional examples.

**Unit 4**

**Ordinary and Partial Differential Equations:** ODE's Initial value problem: Euler's methods, Runge-Kutta methods, Predictor-corrector methods, Adaptive step size. Introduction to partial differential equations.

**Unit 5**

**Numerical Differentiation and Integration:** Numerical differentiation, higher order formulae, Integral equations- Trapezoidal rules, Simpson's rules, Quadrature.

**Reference Books:**

1. Gupta S.K. (1995) Numerical Methods for engineers, New Age International.
2. Chapra S.C. and Canale R.P. (2006) Numerical Methods for Engineering, 5th edition, Mc Graw Hill.
3. S. P. Venkateshan, Prasanna Swaminathan, Computational Methods in Engineering, Ane Books.
4. Joe D Hoffman, Numerical Methods for Engineers and Scientists, Second Edition, Marcel Dekker (2001).
5. Gilbert Strang, Computational Science and Engineering, Wellesley-Cambridge Press.

**Course Outcomes**

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

**CO1**: Understand the importance of mathematical modeling and be able to develop mathematical models of physical phenomena.

**CO2**: Get the knowledge of solving and applying important engineering equations to different models.

**CO3**: Able to implement numerical approximations in various problems.

**CO4**: Able to solve ordinary and partial differential equation analytically and numerically.

**CO5**: Will learn to solve integral equation analytically as well as numerically.

# OPEN ELECTIVE - 2

## Reliability and Maintenance Engineering (MET-044)

**L T P: 3 0 0**

**Course Objectives**

The course will enable the students to:

- To understand the concept to reliability.
- To understand basic maintenance terms and know methods and techniques for planning, scheduling, carry out and analyze maintenance.
- Information about the most relevant and future maintenance concepts.
- To carry out risk and vulnerability analyses and to use maintenance optimization models.
- To get information about environmental aspects related to Maintenance engineering.

**Particulars**

**Unit 1** **(8 Hrs)**

**Reliability:** Introduction and definition about reliability, Probabilistic nature of failures. Mean failure rate and meantime between failures (MTBF) of component/system: Problems Hazard rate and Hazard models Problems Weibull model for reliability of components/systems. Reliability of components in Series configuration. Reliability of components in Parallel configuration. Redundant and Mixed configurations System reliability improvement. Case studies in reliability of system.

**Unit 2** **(8 Hrs)**

**Maintainability:** Introduction and definition of maintainability, availability. Choice of maintenance strategy. Factors contributing to Mean Down Time (MDT): Problems Mean time to repair (MTTR): Problems Fault diagnosis, and routine testing forum revealed faults. Factors contributing to Mean Maintenance Time (MMT): Problems Types of maintenance Economics of maintenance.

**Unit 3** **(8 Hrs)**

**Maintenance Strategies**: Break down maintenance, planned maintenance, strategies, preventive maintenance, design out maintenance, planned lubrication, total productive maintenance, zero break down, preventive inspection of equipment used in emergency.

**Unit 4** **(8 Hrs)**

Replacement planning maintain or replace decision, replacement of items that deteriorate identical equipment, replacement of items that fail without deterioration individual, group replacement, replacement in anticipation of failure. Break down maintenance planning.

**Unit 5** **(8 Hrs)**

Maintenance Management, production maintenance system, objectives and functions, forms, policy, planning, organization, economics of maintenance, manpower planning, materials planning, spare parts planning and control, evaluation of maintenance management.

**Reference Books:**

1. Industrial Safety Handbook: William Handley.
2. Introduction to Safety Engineering: David S Gloss & Miriam Gayle Wardle.
3. Industrial Safety: Roland P Blake.
4. Industrial Hazard & Safety Handbook: Ralph King & John Magid.

**Course Outcomes**

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

**CO1:** Explain the concept to reliability.

**CO2:** Understand the concept of maintainability of a system.

**CO3:** Gain the knowledge about the concept of maintenance strategies.

**CO4:** Explain the concept of replacement planning.

**CO5:** Explain the concept of maintenance management.

# OPEN ELECTIVE - 3

## Project Management (MAT-045)

**L T P: 3 0 0**

**Course Objectives:**

The course will enable the students to:

- Gain an understanding about the basics of project management.
- Learn the implementation of various project management concepts.
- Gain knowledge of procurement.
- Learn to implement various project controls.
- Write and complete different types of projects.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction:** Characteristics of a project types of projects, Project Management Body of Knowledge (PMBOK), role of project manager and his qualities, project organization and benefits, idea generation, needs of society, import substitution, project lifecycle, project charter, project sponsor.

**Project Planning**: Customer needs, stakeholder concept, project scope, feasibility study and report, baseline plan, SWOT analysis, project organization structure and hierarchy, project teams, formation, attitude and aptitude.

**Unit 2** **(8 Hrs)**

**Structure:** Project selection methods, breakeven analysis, DCF methods, project implementation, estimation, cost, price, value, scheduling, bar charts, network diagrams, PERT and CPM, schedule crashing, simple introduction to risk management, probability in project management, decision trees.

**Unit 3** **(8 Hrs)**

**Procurement:** Vendor selection methods, JIT, supply chains, quality, quality circles, quality control and quality assurance, cause and effect analysis, ISO and concepts of total quality management and six sigma, resource planning and allocation, availability and constraints of resources, resource leveling and crashing.

**Unit 4** **(8 Hrs)**

**Project Control**: Project scope, project change request, and control of schedule, resources, cost and quality, project communications, channels, means, meetings, project reports, project audits Project evaluation, project close-out reports, guidelines, audit reports, maintenance and shutdown projects, plant turn- around and brief introduction to replacement analysis.

**Unit 5** **(8 Hrs)**

**Projects:** Contour maps, sitemaps, plant layout, suitability of project site, preparation of site, selection and leasing of construction equipment special considerations in selection and location of projects, safety, health, human and environment al factors, project finance, international projects, joint ventures, collaborations, impact of culture, implementation, and handing over of projects.

**Text book:**

Kamarajuramakrishna, "Essentials of project management", PHI Learning, New Delhi, 2010.

**Reference Books:**

1. Prasannachandra, "Projects - planning, analysis, selection, implementation and review", Tata McGraw-Hill, New Delhi, 2010.

2. Chitkara, "Construction project management", Tata McGraw- Hill, New Delhi.

3. Harold kerzner, "Project Management", Wiley, New York.

**Course Outcomes:**

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

**CO1:** Explain the basics of project management.

**CO2:** Implement the project management concepts.

**CO3:** Apply project procurement rules.

**CO4**: Implement various project controls to real projects.

**CO5:** Prepare complete project reports.

# OPEN ELECTIVE - 4

## Six Sigma (MAT-046)

**L T P: 3 0 0**

**Course Objectives**

The course will enable the students to:

- Get aware about the quality perception and learn about descriptive statistics methods.
- Learn basics of Six Sigma.
- Learn about the different methodologies and implementation of Six Sigma.
- Learn about different Six Sigma tools.
- Learn about software's used with Six Sigma.

**Particulars**

**Unit 1** **(8 Hrs)**

**Quality Perception:** Quality in Manufacturing, Quality in Service Sector; Differences between Conventional and Six Sigma concept of quality; Six Sigma success stories. Statistical foundation and methods of quality improvement.

**Descriptive statistics:** Data Type, Mean, Median, Mode, Range, Variation, Standard Deviation, Skewness, Kurtosis.

**Probability Distribution:** Normal, Binomial, Poisson Distribution.

**Unit 2** **(8 Hrs)**

**Basics of Six Sigma:** Concept of Six Sigma, Defects, DPMO, DPU, Attacks on X'S, Customer focus, Six Sigma for manufacturing, Six Sigma for service. Z score, Understanding Six Sigma organization, Leadership council, Project sponsors and champions, Master Black Belt, Black Belt, Green Belts.

**Unit 3** **(8 Hrs)**

Methodology of Six Sigma, DMAIC, DFSS, Models of Implementation of Six Sigma, Selection of Six Sigma Projects.

**Unit 4** **(8 Hrs)**

Six Sigma Tools: Project Charter, Process mapping, Measurement system analysis, Hypothesis Testing, Quality Function deployment, Failure mode effect analysis, Design of Experiments.

**Unit 5** **(8 Hrs)**

Sustenance of Six Sigma, Communication plan, Company culture, Reinforcement and control, Introduction to softwares for Six Sigma, Understanding Minitab, Graphical analysis of Minitab plots.

**Reference Books:**

**1.** Six Sigma: SPC and TQM in manufacturing and service, Geoff Tennant, Gower Publishing Co.

**2.** Six Sigma for managers, Greg Brue, TMH

**3.** What is Six Sigma, Pete Pande, TMH

**4.** The Six Sigma Way, Peter S. Pande, TMH Team Field book

**5.** The Six Sigma way, Peter S. Pande, TMH

**Course Outcomes**

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

**CO1**: Understand quality perception and learn about descriptive statistics methods.

**CO2**: Learn basics of six sigma.

**CO3**: Learn about the different methodologies of six sigma.

**CO4**: Apply different six sigma tools.

**CO5**: Learn software's used with six sigma.

**Project Stage - III (RAP-011)**

## Course Objectives

The course should enable the students:

- To allow students to demonstrate a wide range of the skills learned during their course of study
- To encourage multidisciplinary research through the integration learned in a number of courses.
- To allow students to develop problem solving, analysis, synthesis and evaluation skills.
- To encourage teamwork.
- To improve students' communication skills by asking them to produce both a professional report and to give an oral presentation

## Course Outcomes

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

**CO1:** Demonstrate a sound technical knowledge of their selected project topic.

**CO2:** Undertake problem identification, formulation and solution.

**CO3:** Combine the theoretical and practical concepts studied in his / her academics.

**CO4:** Communicate with engineers and the community at large in written and oral forms.

**CO5:** Demonstrate the knowledge, skills and attitudes of a professional engineer.