# Bachelor of Technology (Mechatronics Engineering)

# Kurukshetra University, Kurukshetra

***SCHEME OF STUDIES/EXAMINATIONS w. e. f.* 2020-21 onwards**

**Semester–V**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **S.**  **No.** | **Course No.** | **Course Title** | **L:T:P** | **Hours/**  **Week** | **Credits** | **Examination Schedule (Marks)** | | | | **Duration of Exam**  **(Hours)** |
| **Major Test** | **Minor Test** | **Practical** | **Total** |
| 1 | #HM-905A | Entrepreneurship | 3:0:0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 2 | MTC-301A | Communication Systems | 3:1:0 | 4 | 4 | 75 | 25 | 0 | 100 | 3 |
| 3 | MTC-303A | Production Technology-II | 3:0:0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 4 | MTC-305A | Automatic Control Systems | 3:0:0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 5 | MTC-307A | Embedded Systems-I | 3:0:0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 6 | MTC-309LA | Communication Systems Lab | 0:0:2 | 2 | 1 | 0 | 40 | 60 | 100 | 3 |
| 7 | MTC-311LA | Production Technology-II Lab | 0:0:4 | 4 | 2 | 0 | 40 | 60 | 100 | 3 |
| 8 | MTC-313LA | Embedded Systems-I Lab | 0:0:2 | 2 | 1 | 0 | 40 | 60 | 100 | 3 |
| 9 | MTC-315LA | Project-I | 0:0:2 | 2 | 1 | 0 | 0 | 100 | 100 | 3 |
| 10 | \*MTC-317A | Industrial Training-II | 2:0:0 | 2 | - | 0 | 100 | 0 | 100 |  |
| 11 | \*\*MC-903A | Essence of Indian Traditional  Knowledge | 3:0:0 | 3 | - | 100 | - | - | 100 | 3 |
|  |  | Total | 20:1:10 | 31 | 21 | 375 | 245 | 280 | 900 |  |

**Note:**

1. *\*MTC-317A is a mandatory non-credit course in which the students will be evaluated for the industrial training undergone after 4th semester.*
2. *\*\*MC-903A is a mandatory credit-less course in which the students will be required to get passing marks in the major test.*
3. *Students are allowed to use programmable scientific calculator during examination.*
4. *#The courses are common with B. Tech. Mechanical Engineering.*

# Bachelor of Technology (Mechatronics Engineering)

# Kurukshetra University, Kurukshetra

***SCHEME OF STUDIES/EXAMINATIONS w. e. f.* 2020-21 onwards**

**Semester–VI**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **S.**  **No.** | **Course No.** | **Course Title** | **L:T:P** | **Hours/**  **Week** | **Credits** | **Examination Schedule (Marks)** | | | | **Duration of Exam**  **(Hours)** |
| **Major Test** | **Minor Test** | **Practical** | **Total** |
| 1 | #HM-901A | Organizational Behaviour | 3:0:0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 2 | MTC-302A | Embedded Systems-II | 3:0:0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 3 | MTC-304A | Pneumatic and Hydraulic Instrumentation | 3:0:0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 4 | MTP\* | Program Elective-I | 3:0:0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 5 | MTP\* | Program Elective-II | 3:0:0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 6 | MTC-306LA | Embedded Systems-II Lab | 0:0:3 | 3 | 1.5 | 0 | 40 | 60 | 100 | 3 |
| 7 | MTC-308LA | Pneumatic and Hydraulic Instrumentation Lab | 0:0:3 | 3 | 1.5 | 0 | 40 | 60 | 100 | 3 |
| 8 | MTC-310LA | Project-II | 0:0:6 | 6 | 3 | 0 | 0 | 100 | 100 | 3 |
|  |  | Total | 15:0:12 | 27 | 21 | 375 | 205 | 220 | 800 |  |

|  |  |  |  |
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| **Program Elective-I** | | **Program Elective-II** | |
| **Course No.** | **Course Title** | **Course No** | **Course Title** |
| MTP-302A | Internal Combustion Engines | MTP-308A | Computer Aided Design and Manufacturing |
| MTP-304A | Refrigeration and Air Conditioning | MTP-310A | Microcontrollers |
| MTP-306A | Digital Image Processing | MTP-312A | Automobile Engineering and Autotronics |

***Note:***

*1. All the students have to undergo 4 to 6 weeks Industrial Training after 6th semester which will be evaluated in 7th semester.*

*2. The course of Program Elective will be offered at 1/3rd strength or 20 students (whichever is smaller) of the section.*

*3. Students are allowed to use programmable scientific calculator during examination.*

*4.#The courses are common with B. Tech. Mechanical Engineering.*

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| **S.**  **No** | **Course No.** | **Course Title** | **L:T:P** | **Hours/**  **Week** | **Credits** | **Examination Schedule (Marks)** | | | | **Duration of Exam**  **(Hours)** |
| **Major Test** | **Minor Test** | **Practical** | **Total** |
| 1 | MTO\* | Open Elective-I | 3:0:0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 2 | MTC-401A | Robotics and Automation | 3:0:0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 3 | MTP\* | Program Elective-III | 3:0:0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 4 | MTP\* | Program Elective-IV | 3:0:0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 5 | MTC-403LA | Robotics and Automation Lab | 0:0:2 | 2 | 1 | 0 | 40 | 60 | 100 | 3 |
| 6 | MTC-405LA | Project-III | 0:0:8 | 8 | 4 | 0 | 100 | 100 | 200 | 3 |
| 7 | \*MTC-407A | Industrial Training-III | 2:0:0 | 2 | - | 0 | 100 | 0 | 100 |  |
|  |  | Total | 14:0:10 | 24 | 17 | 300 | 240 | 160 | 700 |  |

# Bachelor of Technology (Mechatronics Engineering)

# Kurukshetra University, Kurukshetra

***SCHEME OF STUDIES/EXAMINATIONS w. e. f.* 2021-22 onwards**

**Semester–VII**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Course No.** | **Program Elective-III** | **Course No.** | **Program Elective-IV** | **Course No.** | **Open Elective-I** |
| MTP-401A | Advanced Manufacturing Technology | MTP-407A | Renewable Energy Resources | MTO-401A | Applied Numerical Techniques and Computer Programming |
| MTP-403A | Finite Element Methods | MTP-409A | Computational Fluid Dynamics | MTO-403A | Non-Destructive Testing |
| MTP-405A | Smart Materials | MTP-411A | Consumer Electronics | MTO-405A | Internet of Things |

***Note:***

*1.\*MTC-407A is a mandatory non-credit course in which the students will be evaluated for the industrial training undergone after 6th semester and students will be required to get passing marks to qualify.*

*2. \*The course of both Program Elective and Open Elective will be offered at 1/3rd strength or 20 students (whichever is smaller) of the section.*

*3. Students are allowed to use programmable scientific calculator during examination.*

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| **S.**  **No.** | **Course No.** | **Course Title** | **L:T:P** | **Hours/**  **Week** | **Credits** | **Examination Schedule (Marks)** | | | | **Duration of Exam**  **(Hours)** |
| **Major Test** | **Minor Test** | **Practical** | **Total** |
| 1 | MTC-402LA | Project-IV | 0:0:10 | 10 | 5 | - | 100 | 100 | 200 | 3 |
| 2 | MTO\* | Open Elective-II | 3:0:0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 3 | MTO\* | Open Elective-III | 3:0:0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 4 | MTP\* | Program Elective-V | 3:0:0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 5 | MTP\* | Program Elective-VI | 3:0:0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
|  |  | Total | 12:0:10 | 22 | 17 | 300 | 200 | 100 | 600 |  |

# Bachelor of Technology (Mechatronics Engineering)

# Kurukshetra University, Kurukshetra

***SCHEME OF STUDIES/EXAMINATIONS w. e. f.* 2021-22 onwards**

**Semester–VIII**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Course No.** | **Program Elective-V** | **Course No.** | **Program Elective-VI** | **Course No.** | **Open Elective-II** | **Course No.** | **Open Elective-III** |
| MTP-402A | Non-Conventional Machining | MTP-408A | Artificial Intelligence & Expert Systems | MTO-402A | Sound and Noise Control | MTO-408A | Operation Research and Optimization Techniques |
| MTP-404A | Welding Technology | MTP-410A | Micro Electro Mechanical Systems | MTO-404A | Lubricants and Lubrication | MTO-410A | Sensors and Actuators |
| MTP-406A | Industrial Ergonomics | MTP-412A | Quality and Reliability Engineering | MTO-406A | Competitive Manufacturing Systems | MTO-412A | Solar Energy |

***Note:***

*1. The course of both Program Elective and open elective will be offered at 1/3rd strength or 20 students (whichever is smaller) of the section.*

*2. Students are allowed to use programmable scientific calculator during examination*

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|  | **B.Tech (5th Sem) Mechatronics Engineering** | | | | | | |
| **HM- 905 A** | **Entrepreneurship** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make the students conversant with the basics concepts in management thereby leading to nurturing their managerial skills.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able understand who the entrepreneurs are and what competences needed to become an Entrepreneur.** | | | | | | |
| **CO 2** | **Students will be able understand insights into the management, opportunity search, identification of a Product; market feasibility studies; project finalization etc. required for small business enterprises.** | | | | | | |
| **CO 3** | **Students can be able to write a report and do oral presentation on the topics such as product identification, business idea, export marketing etc.** | | | | | | |
| **CO4** | **Students will be able to know the different financial and other assistance available for the small industrial units.** | | | | | | |

**UNIT –I**

**Entrepreneurship :** Concept and Definitions; Entrepreneurship and Economic Development; Types of Entrepreneurs; Factor Affecting Entrepreneurial Growth – Economic, Non-Economic Factors; EDP Programmes; Entrepreneurial Training; Traits/Qualities of an Entrepreneurs; Manager Vs. Entrepreneur, types of entrepreneurships, Entrepreneurial myths.

**UNIT-II**

**Opportunity Identification and Product Selection:** Entrepreneurial Opportunity Search &Identification; Criteria to Select a Product; Conducting Feasibility Studies; Sources of business ideas, launching a new product; export marketing, Methods of Project Appraisal, Project Report Preparation; Project Planning and Scheduling. Sources of finance for entrepreneurs.

**UNIT –III**

**Small Enterprises and Enterprise Launching Formalities :** Definition of Small Scale; Rationale; Objective; Scope; SSI; Registration; NOC from Pollution Board; Machinery and Equipment Selection , Role of SSI in Economic Development of India; major problem faced by SSI,MSMEs – Definition and Significance in Indian Economy; MSME Schemes, Challenges and Difficulties in availing MSME Schemes.

**UNIT -IV**

**Role of Support Institutions and Management of Small Business :** Director of Industries; DIC; SIDO;SIDBI; Small Industries Development Corporation (SIDC); SISI; NSIC; NISBUD; State Financial Corporation SIC; Venture Capital : Concept, venture capital financing schemes offered by various financial institutions in India, Legal issues – Forming business entity, considerations and criteria, requirements for formation of a Private/Public Limited Company,

**Note:**

• Exercises / activities should be conducted on ‘generating business ideas’ and identifying problems and opportunities.

• Interactive sessions with Entrepreneurs, authorities of financial institutions, Government officials should be organized.

**Suggested Readings:**

1. “Entrepreneurship development small business enterprises”, Pearson, Poornima M Charantimath,2013.
2. Roy Rajiv, “Entrepreneurship”, Oxford University Press, 2011.
3. “Innovation and Entrepreneurship”,Harper business- Drucker.F, Peter, 2006.
4. “Entrepreneurship”, Tata Mc-graw Hill Publishing Co.ltd new Delhi- Robert D. Hisrich, Mathew J. Manimala, Michael P Peters and Dean A. Shepherd, 8th Edition, 2012
5. Enterpreneurship Development- S.Chand & Co.,Delhi- S.S.Khanka 1999
6. Small-Scale Industries and Entrepreneurship. Himalaya Publishing House, Delhi –Vasant Desai 2003.
7. Entrepreneurship Management -Cynthia, Kaulgud, Aruna, Vikas Publishing House, Delhi, 2003.
8. Entrepreneurship Ideas in Action- L. Greene, Thomson Asia Pvt. Ltd., Singapore, 2004.

**Note: Question Paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.**

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|  | **B.Tech (5th Sem) Mechatronics Engineering** | | | | | | |
| **MTC-301A** | **Communication Systems** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **1** | **-** | **4** | **75** | **25** | **100** | **4h** |
| **Purpose** | **To make the students conversant with the basics concepts of Communication Systems.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to explain concepts of noise and its mathematical representation.** | | | | | | |
| **CO 2** | **Students will be able to apply the fundamentals of Modulation of sound.** | | | | | | |
| **CO 3** | **Students will be able to analyze the concepts of digital transmission of analog signals.** | | | | | | |
| **CO 4** | **Students will understand fundamentals of optical fibre communications and noises in communication systems** | | | | | | |

**UNIT I**

**Noise:** Classification of Noise, Various sources of Noise, Methods of Noise Calculation in networks and inter connected networks. Addition of noise due to several sources; noise in amplifiers in cascade, noise in reactive circuits, Noise figure, its calculation and measurement. Noise temperature, Mathematical representation of random noise, narrow band noise and its representation. Transmission of noise through linear systems, signal to noise ratio, noise bandwidth.

**UNIT II**

**Analog Modulation techniques:** Information source, encoder, transmitter, channel/medium, receiver, decoder and information sink. Need for modulation, Baseband and Pass band signals, Amplitude Double side band with Carrier (DSB-C), Double side band without Carrier, Single Side Band Modulation, DSB-SC, DSB-C, SSB Modulators and Demodulators, Vestigial Side Band (VSB), Quadrature Amplitude Modulator, Frequency Modulation. Radio Transmitter and Receiver.

**UNIT III**

**Digital Data transmission:** Line coding review, Pulse shaping, Scrambling, PCM.Method of generation and detection of coherent & non-coherent binary ASK, FSK & PSK Pulse Modulation

**Digital Transmission of Analog Signals:** Sampling Theorem and its applications, Pulse Amplitude Modulation (PAM), Pulse Width Modulation, Pulse Position Modulation. Their generation and Demodulation. Pulse Code Modulation (PCM), Frequency Division Multiplexing, Time Division Multiplexing, Line Coding and their Power Spectral density and Code Division Multiplexing.

**UNIT IV**

**Optical Fibre communications and Noises in Communication systems:** Basic Block Diagram, Advantages & Disadvantages of Optical Fiber Communication, Ray Theory, Electromagnetic Mode Theory, Step Index Fiber, Graded Index Fiber, Attenuation- Bending Loses, Scattering, Absorption, Dispersion. Application of optical fibers, Noise in communications, performance comparisons in the presence of noise, Noise in Amplitude Modulation: Analysis ,Signal to Noise Ratio, Figure of Merit, Noise in Frequency Modulation: Pre emphasis, De Emphasis and SNR Improvement, Phase Locked Loops .

**TEXT BOOKS:**

1. Haykin S., Mohr M., 2006, An Introduction to Analog and Digital Communications, 2nd Ed, Wiley, ISBN: 978-0-471-43222-7

2.Haykin S., 2009, Communication Systems, International Student Version, 5th Ed, Wiley, ISBN: 978-0-470-16996-4

**REFERENCE BOOKS:**

1. Otung I., 2001, Communication Engineering Principles, Palgrave Macmillan, ISBN: 9780333775226

2. Proakis J. G., Salehi M., Bauch G., 2004, Contemporary Communication Systems Using MATLAB, 2nd Edition, Thomson Boos/Cole, ISBN: 97805344061

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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|  | **B.Tech (5th Sem) Mechatronics Engineering** | | | | | | |
| **MTC-303A** | **Production Technology-II** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make the students conversant with the fundamentals of Production Technology.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will understand the concepts of kinematics of machine tools.** | | | | | | |
| **CO 2** | **Students will be able to apply the knowledge of manufacturing of gears and Automatic lathe.** | | | | | | |
| **CO 3** | **Students will be able to explain fundamentals of unconventional machining processes & press tool design.** | | | | | | |
| **CO 4** | **Students will be able to analyze press and fits.** | | | | | | |

**UNIT I**

**Kinematics of Machine Tools:** Introduction, drives in machine tools, mechanical drive: conversion of rotary motion into rotary motion, conversion of rotary motion into rectilinear reciprocating motion, selecting maximum and minimum cutting speeds and feeds, upper and lower speed limits of a lathe, stepped and step less drives, characteristics of mechanical stepped drive, series in spindle speed A.P., G.P. and Logarithmic progressions, stand value of ratio, designing layout for mechanical stepped drives, Kinematics calculation of speed gear boxes, stepless mechanical drives.

**UNIT II**

**Gear manufacturing and layout for Automatics:** Methods of gear manufacturing, classification of methods, milling, broaching, the process of gear generating, hobbing, hobbing machine relationship, estimating hob time, gear shaping hobbing v/s milling, hobbing v/s shaping, bevel gear cutting, worm gears, gear finishing methods, gear burnishing, gear grinding, gear lapping, gear honning.

**Automatic lathes**: classification of automatic machines, setting up of automatics, tooling layout and operation sheet, cam design, tool layout of automatic screw machine, programmed automatic lathes, bar stock feeding.

**UNIT III**

**Constructional Features of CNC machines:** Classifications of CNC Machine, Modes of operation of CNC, Working of: Machine Structure, Slideways, Spindle drive, Axis drive, Recirculating ball screw Feedback devices (transducers, encoders), Automatic tool changer (ATC), Automatic pallet changer (APC). CNC axis and motion nomenclature, CNC toolings – tool pre setting, qualified tool, tool holders and inserts.

**UNIT-IV**

**Press:** Introduction, classifications of presses, methods of transmitting power, major components of mechanical press, selecting the proper press, components of die assembly, classification of dies, cutting action in die, punch and die clearance, control of hole and die clearance, cutting forces, shear on punch and dies, punch press energy, centre of pressure, method of calculating centre of pressure.

**Fits:** Concept of interchangeability, basic terminology, types of fits, clearance fits, transition fits, interference fits, selective assembly, system of fits

**TEXT BOOKS:**

1. Manufacturing science: Ghosh and Malik, E.W. Press

2. Modern machining processes: Pandey and Shan, Tata McGraw Hill Publications

**REFERENCE BOOKS:**

1. Principles of metal cutting: Sen and Bhattacharya, New Central Book.

2. Metal cutting principles: Shaw, MIT Press Cambridge

3. Manufacturing analysis: Cook, Adisson-Wesley

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit.*

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|  | **B.Tech (5th Sem) Mechatronics Engineering** | | | | | | |
| **MTC-305A** | **Automatic Control Systems** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make the students acquainted with the basics concepts of automatic control system.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to explain the concepts of control system.** | | | | | | |
| **CO 2** | **Students will be able to evaluate the time domain analysis.** | | | | | | |
| **CO 3** | **Students will be able to understand the fundamentals of stability analysis and compensation techniques.** | | | | | | |

**UNIT 1**

**Introduction of control system:** Concept of control, Classification of control systems, Transfer Functions ,system representation-Analogies, Mathematical modeling of physical system (Mechanical, thermal and electrical system), Block diagram reduction technique, Signal Flow Graph , Control System components ( Servomotors, Techo generators, Stepper motor).

**UNIT-II**

**Time domain analysis:** Typical test signals, Time response of first order systems to various standard inputs (unit step input ,unit ramp input, unit impulse input) time response of 2nd order system (to step input and unit ramp input) , Time domain specifications for under-damped 2nd order system, Steady state error and error constants, Effect of adding poles and zero to a system. Feedback characteristics of control system (Effect of feedback on sensitivity, overall gain and stability).Basic Control actions (P/I,D/PI/PD and PID control)

**UNIT-III**

**Stability anaysis:** Concept of stability, pole zero configuration and stability, necessary and sufficient conditions for stability Routh-Hurwitz stability criterion and relative stability analysis. Root locus concept, Nyquist stability Criterion, frequency response analysis -Bode plot –gain margin and phase margin.

**UNIT-IV**

**Compensation techniques**: Classifications-Lag, Lead and Lag lead compensator, Necessity of compensation, compensation networks, application of lag and lead compensation, basic modes of feedback control, proportional, integral and derivative controllers. Concepts of state, state variables and state model, derivation of state models from block diagrams- State space representations– Solutions of state equations. Concepts of Controllability and Observability

**TEXT BOOKS**:

1. Linear Control System by R.S. Chauhan, (Umesh Publications)

2. Automatic Control System by S.Hasan Saeed (SK Kataria and Sons publications)

3.Linear Control system by B.S.Manke ( khanna Publishers)

**REFERENCE BOOKS:**

1. Control system Engg. By Nagrath and Gopal

2. Control system Engg. By Ogata

3. Automatic Control Systems : B.C.Kuo, PHI

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit.*

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| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **B.Tech (5th Sem) Mechatronics Engineering** | | | | | | |
| **MTC-307A** | **Embedded Systems-I** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make the students conversant with the concepts of Embedded systems-I.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will understand the concepts of Microcontroller.** | | | | | | |
| **CO 2** | **Students will create programs using Assembly and C programming of Microcontroller.** | | | | | | |
| **CO 3** | **Students will be able to apply the knowledge of interfacing of microcontroller.** | | | | | | |
| **CO 4** | **Students will be able to explain the internal architecture and interrupt programming.** | | | | | | |

**UNIT-I**

Introduction to Microcontroller: -Evaluation of Microcontrollers. Classification of Microcontroller – On the basis of architecture and instruction set. Embedded processor. Comparison between Microprocessor and Microcontrollers. A brief history of 8051.Overview of 8051 microcontroller family. Block Diagram and Architecture of 8051. Pin Description of 8051 microcontroller.

**UNIT-II**

Assembly and C programming of Microcontroller :- 8051 Instruction Format, Addressing modes, Data transfer instructions. Logical operations, Arithmetic operations, looping, jump and call instructions, Time Delay programming. SFR (Special Function Registers).Development of different programs. Data types and Time Delays in 8051 C. Logic and Arithmetic operation in C.

**UNIT-III**

8051 Internal Architecture: - I/O port programming. Serial communication using 8051.Counter and Timers programming. Different modes of timer. Serial data input / output, Setting Baud Rate. Interrupt Programming –timer interrupts, external hardware interrupts, serial communication interrupt, priority interrupt. External memory interfacing.

**UNIT-IV**

Interfacing of microcontroller: Microcontroller based seven segment numeric displays. Microcontroller interfacing with keypad, Microcontroller based D/A& A/D converters and Microcontroller based LCD display. Motor interfacing with microcontroller 8051.

**TEXT BOOKS**

1. The 8051 Microcontroller And Embedded Systems Using Assembly And C: Muhammad Ali Mazidi.

2. The 8051 Microcontroller: Kenneth J. Ayala

**REFERENCE BOOKS**

1. The 8051 Microcontroller: Mackenzie

2. 8051 Microcontroller: Internals, Instructions, Programming & Interfacing: Ghoshal Subrata

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit.*

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| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **B.Tech (5th Sem) Mechatronics Engineering** | | | | | | |
| **MTC-309LA** | **Communication Systems lab** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **-** | **-** | **2** | **1** | **60** | **40** | **100** | **3h** |
| **Purpose** | **To make students acquainted with concepts and experiments of Communication Systems.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to demonstrate Carrier modulation techniques.** | | | | | | |
| **CO 2** | **Students will be able to perform experiments for AM and FM Modulation/ Demodulation.** | | | | | | |
| **CO 3** | **Students will be able to evaluate Time Division Multiplexing & De-multiplexing.** | | | | | | |
| **CO 4** | **Students will be able to elaborate CRO** | | | | | | |

**LIST OF EXPERIMENTS:**

1. To understand the different waveleforms and their parameters on CRO.
2. To observe sampling theorem waveforms on CRO.
3. To observe AM Modulation/Demodulation waveforms on CRO.
4. To observe FM Modulation / Demodulation on CRO.
5. To observe PAM Modulation / Demodulation waveforms on CRO.
6. To observe Delta Adaptive Modulation / Demodulation waveforms on CRO.
7. To observe PCM Modulation / Demodulation waveforms on CRO.
8. To observe Carrier Modulation technique using ASK on CRO.
9. To observe Carrier Modulation technique using FSK on CRO.
10. To observe Carrier Modulation technique using PSK on CRO.
11. Comparative study of Delta Modulation & Adaptive Delta Modulation Technique on CRO.
12. To observe Time Division Multiplexing & De-multiplexing on CRO.

**NOTE:** Student will be required to perform total of 10 experiments. 8 experiments will be from the below given list and rest experiments will be designed based upon the curriculum.

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|  | **B.Tech (5th Sem) Mechatronics Engineering** | | | | | | |
| **MTC-311LA** | **Production Technology-II Lab** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **-** | **-** | **4** | **2** | **60** | **40** | **100** | **3h** |
| **Purpose** | **To make students knowledgeable about the fundamentals of Production Technology.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to understand the concepts of Milling machine.** | | | | | | |
| **CO 2** | **Students will be able to elaborate the working of surface grinder and gear hobbing.** | | | | | | |
| **CO 3** | **Students will be able to attain knowledge about CNC, Boring and TIG/MIG welding.** | | | | | | |
| **CO 4** | **Students will be able to attain knowledge about Shaper and dynamometer.** | | | | | | |

**NOTE:** Student will be required to perform total of 10 experiments. 7 experiments will be from the below given list and rest experiments will be designed based upon the curriculum.

**LIST OF EXPERIMENTS:**

1. Introduction to milling machines its types functions applications etc.

2. Practice of slab milling on milling machine.

3. Practice of slotting on milling machine.

4. To cut gear teeth on milling machine using dividing head.

5. Introduction to gear hobber, demonstration of gear hobbing and practice.

6. Introduction to various grinding wheels and demonstration on the surface grinder.

7. Introduction to tool and cutter grinder and dynamometer.

8. Study the constructional detail and working of CNC lathes Trainer.

9. To carry out welding using TIG/MIG welding set.

10. Introduction, demonstration & practice on profile projector & gauges.

11. To make a component on lathe machine using copy turning attachment.

12. To cut external threads on a lathe.

13. To cut multi slots on a shaper machine.

14. To perform drilling and Boring operation on a Component

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|  | **B.Tech (5th Sem) Mechatronics Engineering** | | | | | | |
| **MTC-313LA** | **Embedded Systems-I Lab** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **-** | **-** | **2** | **1** | **60** | **40** | **100** | **3h** |
| **Purpose** | **To make students knowledgeable about the fundamentals of Embedded Systems.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to evaluate Microcontroller and LED.** | | | | | | |
| **CO 2** | **Students will be able to work on On/Off relay and DC motor.** | | | | | | |
| **CO 3** | **Students will be able to elaborate about ACD LCD module.** | | | | | | |

**LIST OF EXPERIMENTS:**

* + - 1. Introduction to microcontroller and interfacing modules.
      2. Write a code to add two numbers using 8051.
      3. Write a assembly program to demonstrate conditional statements.
      4. To interface the seven segment display with microcontroller 8051.
      5. To create a series of moving lights using 8051 on LEDs.
      6. To interface the stepper motor with microcontroller.
      7. To display the digital output of ADC on 16\*2 LCD Module.
      8. To display character “A” on 8\*8 LED Matrix.
      9. To display the data and time on LCD Module.
      10. To switch on and off relay by using keys.
      11. To interface the DC motor using H-Bridge.
      12. To interface a keypad with microcontroller.

**NOTE:** Student will be required to perform total of 10 experiments. 8 experiments will be from the below given list and rest experiments will be designed based upon the curriculum.

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|  | **B.Tech (5th Sem) Mechatronics Engineering** | | | | | | |
| **MTC-315LA** | **Project I** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **-** | **-** | **2** | **1** | **100** | **0** | **100** | **3h** |
| **Purpose** | **To be able to apply some of the techniques/principles that have been taught to carry out time and budget planning for the project.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Demonstrate a thorough and systematic understanding of project contents.** | | | | | | |
| **CO 2** | **Understand methodologies and professional way of documentation and communication.** | | | | | | |
| **CO 3** | **Know the key stages in development of the project** | | | | | | |
| **CO 4** | **Extend or use the idea in mini project for major project.** | | | | | | |

The project will be individual practical and investigative, requiring the student to investigate the existing background, theories and knowledge as applied to a problem in the design and/or operation of an existing or new process or product. By practical measurement, design, implementation and above all, creativity, the student will arrive at a solution based on sound engineering principles worked in previous semester. The project will be integrative, deploying and extending the range of skills and knowledge previously and concurrently developed.

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|  | **B.Tech (5th Sem) Mechatronics Engineering** | | | | | | |
| **MTC-317A** | **Industrial Training – II** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **2** | **-** | **-** | **-** | **-** | **100** | **100** | **-** |
| **Purpose** | **To provide comprehensive learning platform to students where they can enhance their employ ability skills and exposure to the industrial environment.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Capability to acquire and apply fundamental principles of engineering.** | | | | | | |
| **CO 2** | **Become updated with all the latest changes in technological world.** | | | | | | |
| **CO 3** | **Capability and enthusiasm for self-improvement through continuous professional development and life- long learning** | | | | | | |
| **CO 4** | **Awareness of the social, cultural, global and environmental responsibility as an engineer.** | | | | | | |

Student will submit summer training report of 5 to 6 week industrial training for his/her assessment. The evaluation will be made based upon the report submitted by student and presentation of work done in industry during the specified period.

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|  | **B.Tech (5th Sem) Mechatronics Engineering** | | | | | | |
| **MC-903A** | **ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE** | | | | | | |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **0** | **0** | **100** | **-** | **100** | **3 Hrs.** |
| **Purpose** | **To understand the values of Indian tradition.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO1** | **Students will be able to understand the concept of Traditional knowledge and its importance** | | | | | | |
| **CO2** | **Students will be able to know the need and importance of protecting traditional knowledge.** | | | | | | |
| **CO3** | **Students will be able to know the various enactments related to the protection of traditional knowledge.** | | | | | | |
| **CO4** | **Students will be able to understand the concepts of Intellectual property to protect the traditional knowledge.** | | | | | | |

## UNIT-I

## INTRODUCTION TO TRADITIONAL KNOWLEDGE Define traditional 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), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge.

**UNIT-II**

## PROTECTION OF TRADITIONAL KNOWLEDGE

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

## LEGAL FRAMEWORK AND TK

A: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); B: The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016. Geographical indicators act 2003

**UNIT-III**

## 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 FORA for increasing protection of Indian Traditional Knowledge.

**UNIT-IV**

**TRADITIONAL KNOWLEDGE IN DIFFERENT SECTORS:** Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, 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 TK. 139

## Text Books:

1. Environmental Studies- Deswal and Deswal. Dhanpat Rai and Co.
2. Environmental Science and Engineering Anandan, P. and Kumaravelan, R. 2009. Scitech Publications (India) Pvt. Ltd., India.
3. Environmental Studies. Daniels Ranjit R. J. and Krishnaswamy. 2013. Wiley India.
4. Environmental Science- Botkin and Keller. 2012. Wiley, India

## Reference Books:

1. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.
2. "Knowledge Traditions and Practices of India" Kapil Kapoor1, Michel Danino

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|  | **B.Tech (6th Sem) Mechatronics Engineering** | | | | | | |
| **HM-901A** | **ORGANIZATIONAL BEHAVIOUR** | | | | | | |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **Major Test** | **Minor Test** | **Total** | **Time (Hrs.)** |
| **3** | **0** | **0** | **3** | **75** | **25** | **100** | **3** |
| **Purpose:** | **To make the students conversant with the basic concepts of organizational culture and behavior for nurturing their managerial skills.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **An overview about organizational behavior as a discipline and understanding the concept of individual behavior.** | | | | | | |
| **CO 2** | **Understand the concept and importance of personality, emotions and its importance in decision making and effective leadership.** | | | | | | |
| **CO 3** | **Enabling the students to know about the importance of effective motivation and its contribution in group dynamics and resolving conflicts.** | | | | | | |
| **CO 4** | **Understand how to overcome organizational stress by maintaining proper organizational culture and effective communication.** | | | | | | |

## UNIT-I

**Introduction to Organizational Behavior*:*** Concept and importance of Organizational Behavior, Role of Managers in OB, Foundations or Approaches to Organizational Behavior, Challenges and Opportunities for OB.

**Foundation of individual behavior**: Biographical characteristics, concept of Abilities and Learning , Learning and Learning Cycle, Components of Learning, concept of values and attitude, types of attitude, attitude and workforce diversity

## UNIT-II

**Introduction to Personality and Emotions**: Definition and Meaning of Personality, Determinants of Personality, Personality Traits Influencing OB, Nature and Meaning of Emotions, Emotions dimensions, concept of Emotional intelligence

**Perception and individual decision making***:* Meaning of perception, factors influencing perception, Rationaldecision- making process, concept of bounded rationality. Leadership- Trait approaches, Behavioral approaches, Situational approaches, and emerging approaches to leadership.

## UNIT-III

**Motivation**: concept and theories of Motivation, theories of motivation-Maslow, Two Factor theory, Theory X and Y, ERG Theory, McClelland’s Theory of needs, goal setting theory, Application of theories in Organizational Scenario, linkage between MBO and goal setting theory, employee recognition and involvement program.

**Foundations of Group Behavior and conflict management: Defining** and classifying of Groups, stages of group development, Informal and Formal Groups – Group Dynamics, Managing Conflict and Negotiation, a contemporary perspective of intergroup conflict, causes of group conflicts, Managing intergroup conflict through Resolution.

## UNIT-IV

**Introduction to Organizational Communication**: Meaning and Importance of Communication process, importance of Organizational Communication, Effective Communication, Organizational Stress: Definition and Meaning, Sources and Types of Stress, Impact of Stress on Organizations, Stress Management Techniques.

**Introduction to Organization Culture**- Meaning and Nature of Organization Culture, Types of Culture, Managing Cultural Diversity, Managing Change and Innovation – Change at work, Resistance to change, A model for managing organizational change.

## Text Books:

1. Colquitt, Jason A., Jeffery A. LePine, and Michael Wesson. Organizational Behavior: Improving Performance and Commitment in the Workplace. 5thed. New York: McGraw-Hill Education, 2017.
2. Hitt, Michael A., C. Chet Miller, and Adrienne Colella. Organizational Behavior. 4th ed. Hoboken, NJ: John Wiley

## Reference Books:

1. Robbins, Stephen P., and Timothy Judge. Organizational Behavior. 17th ed. Harlow, UK: Pearson Education
2. Stephen P. Robins, Organisational Behavior, PHI Learning / Pearson Education, 11th edition, 2008.

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|  | **B.Tech (6th Sem) Mechatronics Engineering** | | | | | | |
| **MTC-302A** | **Embedded Systems-II** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make the students conversant with the concepts of Embedded systems-II.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will understand the concepts of Microcontroller.** | | | | | | |
| **CO 2** | **Students will be able to understand the fundamentals of Internal architecture of AVR microcontroller.** | | | | | | |
| **CO 3** | **Students will be able to explain the concepts AVR microcontroller interfacing** | | | | | | |
| **CO 4** | **Students will create programs using Assembly and C programming of Microcontroller.** | | | | | | |

**UNIT-I**

**Introduction to microcontrollers:** Evaluation of Microcontrollers- Microcontrollers and Embedded system, Criteria for choosing a microcontroller, Overview of AVR Family, Block diagram of AVR microcontroller, AVR microcontroller I/O pins, AVR microcontroller peripherals, Special purpose AVRs.

**UNIT-II**

**Internal architecture of avr microcontroller:** General purpose registers in AVR, AVR data memory, using instructions with the data memory, IN and OUT instructions, AVR Status Register, AVR data format and directives Introduction to AVR assembly programming, Program counter and program ROM space in AVR, Harvard architecture in AVR, instruction size of the AVR, RISC architecture of AVR.

**UNIT-III**

**Assembly and c programming of microcontroller:** AVR instruction format, addressing modes of AVR microcontroller, Branch Instruction and looping, Call instructions and stack, I/O port programming, I/O bit manipulation in AVR, time delay and instruction pipeline, Arithmetic Instructions, Logical and compare instructions, Rotate and shift instructions, data serialization.AVR timer programming,AVR Interrupt programming and AVR serial port programming in assembly and C.

**UNIT-IV**

**AVR microcontroller interfacing:** LCD interfacing ,Keyboard interfacing, ADC characteristics, ADC programming in AVR, Sensor interfacing and Signal Conditioning DAC Interfacing, Relays and opto isolators, Stepper motor interfacing,DC motor control using PWM.

**TEXT BOOKS:**

1. The AVR Microcontroller and Embedded system using Assembly and C by Muhammad Ali Mazidi-Prentice Hall of India.

**REFERENCE BOOKS:**

1. The Atmel AVR Microcontroller Mega and XMega in Assembly and C by Han-Way Huang- Cengage Learning, 2014.

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit.*

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|  | **B.Tech (6th Sem) Mechatronics Engineering** | | | | | | |
| **MTC-304A** | **Pneumatic and Hydraulic Instrumentation** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students acquainted with the fundamentals of Pneumatic and Hydraulic Instrumentation.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to know with basic concept of pneumatic system.** | | | | | | |
| **CO 2** | **Students will be able to explain the fundamentals of Actuators.** | | | | | | |
| **CO 3** | **Students will be able to elaborate Hydraulic and pneumatic accessories** | | | | | | |
| **CO 4** | **Students will be able to explain the fundamentals of Hydraulic pumps with pressure regulation.** | | | | | | |

**UNIT – I**

**Fundamental principles:** Industrial Prime movers, a brief system comparison, an electrical system, hydraulic system, pneumatic system, definitions of terms: mass and force, pressure, work, energy and power, torque, Pascal‟s law, pressure measurement, fluid flow, temperature scales and temperature measurement, gas laws.

**Basic components of a pneumatic system:** receiver tank, compressors, piston compressors, single acting and double acting compressors, multistage compressors, combined two stage compressors, diaphragm compressors, screw compressors, rotary compressors, dynamic compressors, air treatment: stages of air treatment, filters, air dryers, lubricators, pressure regulation: relief valves, non-relieving pressure regulators, relieving pressure regulators, service units.

**UNIT – II**

**Actuators:** Linear actuators, construction, mounting arrangements, cylinder dynamics, seals, rotary actuators, constructional details, application notes, speed control, actuator synchronization, regeneration, counterbalance and dynamic braking, pilot operated check valves, pre-fill and compression relief.

**UNIT – III**

**Hydraulic pumps and pressure regulation:** pressure regulation, pump types, gear pumps, vane pumps, piston pumps, combination valves, loading valves, filters, Control valves: Graphic symbols, types of control valve, poppet valves, spool valves, rotary valves, pilot operated valves, check valves, pilot operated check valves, restriction check valves, shuttle and fast exhaust valves, sequence valves, time delay valves, servo valves and modular cartridge valves.

**UNIT – IV**

**Hydraulic and pneumatic accessories:** hydraulic reservoirs, hydraulic accumulators, hydraulic coolers, hydraulic fluids, pneumatic piping, hoses and connections, hydraulic piping, hoses and connections, Process Control Pneumatics, signals and standards, the flapper nozzle, volume boosters, the air relay and force balance principle, pneumatic controllers, process control valves and actuators, flow control valves, actuators, valve positioners, converters: I-P converters and P-I converters, sequencing applications

**TEXT BOOKS:**

1. Pneumatic & Hydraulic, Andrew Parr PHI, 1999

2. Pneumatic & Hydraulic, R Srinivasan, vijay nicole

3. Process Control Instrumentation Technology, C. D. Johnson ,PHI, 2002

4. Computer based Industrial Control, Krishankant PHI,2004

**REFERENCE BOOKS:**

1. Process Industrial Instruments & Control Handbook D.Considine , McGraw Hill ,1993.

2. Instrument Engineers Handbook ,B.G liptak ,BH Publication ,1999.

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit.*

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| **PE-I** | **B.Tech (6th Sem) Mechatronics Engineering** | | | | | | |
| **MTP-302A** | **Internal Combustion Engines** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students conversant with the fundamentals of Internal Combustion Engines.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to understand the concepts of Heat Engines CI and SI engines.** | | | | | | |
| **CO 2** | **Students will be able to explain the fundamentals of Ignition system and lubricating system.** | | | | | | |
| **CO 3** | **Students will be able to attain knowledge about air compressor.** | | | | | | |
| **CO 4** | **Students will be able to attain knowledge about cooling system with heat balance.** | | | | | | |

**UNIT-I**

**Heat engines:** Internal and external combustion engines; Classification of I.C. Engines; Cycle of operations in four strokes and two-stroke IC engines; Wankle Engine. Air standard cycles: Assumptions made in air standard cycles; Otto cycle; Diesel cycle; Dual combustion cycle; Comparison of Otto, diesel and dual combustion cycles; Sterling and Ericsson cycles; Air standard efficiency, Specific work output. Specific weight; Work ratio; Mean effective pressure; Deviation of actual engine cycle from ideal cycle. Numericals.

**UNIT-II**

**Ignition system**: Mixture requirements for various operating conditions in S.I. Engines; Elementary carburetor, Calculation of fuel air ratio; The complete carburetor; Requirements of a diesel injection system; Type of injection system; Petrol injection; Requirements of ignition system; Types of ignition systems, ignition timing; Spark plugs. S.I. engines; Ignition limits; Stages of combustion in S. I. Engines; Ignition lag; Velocity of flame propagation; Detonation; Effects of engine variables on detonation; Theories of detonation; Octane rating of fuels; Pre-ignition;

**Combustion:** S.I. engine combustion chambers. Stages of combustion in C.I. Engines; Delay period; Variables affecting delay period; Knock in C.I. Engines; Cetane rating; C.I. Engine combustion chambers..

**UNIT-III**

**Lubricants:** Functions of a lubricating system, Types of lubrication system; Mist, Wet sump and dry sump systems; Properties of lubricating oil; SAE rating of lubricants; Engine performance and lubrication

**Cooling Systems:** Necessity of engine cooling; Disadvantages of overcooling; Cooling systems; Air-cooling, Water-cooling; Radiators. Performance parameters; BHP, IHP, Mechanical efficiency; Brake mean effective pressure and indicative mean effective pressure, Torque, Volumetric efficiency; Specific fuel consumption (BSFG, ISFC); Thermal efficiency; Numerical.

**Heat balance:** Basic engine measurements; Fuel and air consumption, Brake power, Indicated power and friction power, Heat lost to coolant and exhaust gases; Performance curves; Numerical.

**UNIT-IV**

**Compressor and Intercooler:** Working of a single stage reciprocating air compressor; Calculation of work input; Volumetric efficiency; Isothermal efficiency; Advantages of multi stage compression; Two stage compressor with inter-cooling; Perfect inter cooling; Optimum intercooler pressure.

**TEXT BOOKS:**

1. Internal combustion engine by Ramalingam sci-tech publication

2. Internal combustion engine by Ganeshan TMG

**REFERENCES:**

1. Internal combustion engine by Mathur & Sharma

2. Heat power engineering by Dr. V.P. Vasandhani& Dr. D.S. Kumar

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit.*

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| **PE-I** | **B.Tech (6th Sem) Mechatronics Engineering** | | | | | | |
| **MTP-304A** | **Refrigeration and Air Conditioning** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students acquainted with the fundamentals of Refrigeration and Air Conditioning Systems.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to acquaint with the concept of heat pump & refrigerator.** | | | | | | |
| **CO 2** | **Students will be able to explain the fundamentals absorption system and methods of improving COP.** | | | | | | |
| **CO 3** | **To make the students aware about Psychometery and Air conditioning units.** | | | | | | |
| **CO 4** | **Students will be able to know the concepts of Simple vapour compression refrigeration system.** | | | | | | |

**UNIT I**

**Basics of heat pump & refrigerator:** Carnot‟s refrigeration and heat pump; Units of refrigeration; COP of refrigerator and heat pump; Carnot’s COP; ICE refrigeration; evaporative refrigeration; refrigeration by expansion of air; refrigeration by throttling of gas; Vapour refrigeration system; steam jet refrigeration; thermoelectric cooling; adiabatic demagnetization.

**Basic principles of operation of air refrigeration system:** Bell-Coleman air refrigerator; advantages of using air-refrigeration in aircrafts; disadvantages of air refrigeration in comparison to other cold producing methods; simple air refrigeration in air craft; simple evaporative type air refrigeration in aircraft; necessity of cooling the aircraft.

**UNIT II**

**Simple Vapour Compression Refrigeration System:** different compression processes (wet compression, dry or dry and saturated compression, superheated compression); Limitations of vapour compression refrigeration system if used on reverse Carnot cycle; representation of theoretical and actual cycle on T-S and P-H charts; effects of operating conditions on the performance of the system; advantages of vapour compression system over air refrigeration system.

**Methods of improving COP:** flash chamber; flash inter cooler; optimum interstate pressure for two stage refrigeration system; single expansion and multi expansion processes; basic introduction of single load and multi load systems; Cascade systems.

**Basic absorption system:** COP and Maximum COP of the absorption system; actual NH3 absorption system; functions of various components; Li-Br absorption system; selection of refrigerant and absorbent pair in vapour absorption system; Electro refrigerator; Comparison of Compression and Absorption refrigeration systems; nomenclature of refrigerants; desirable properties of refrigerants.

**UNIT III**

**Psychometery:** Difference in refrigeration and air conditioning; Psychometric properties of moist air (wet bulb, dry bulb, dew point temperature, relative and specific humidity of moist air, temperature of adiabatic saturation); empirical relation to calculate Pv in moist air.

**UNIT IV**

**Air Conditioning:** Classification; factors affecting air conditioning systems; comfort air-conditioning system; winter air conditioning system; summer air- conditioning system; year round air conditioning. unitary air-conditioning system; central air conditioning system; room sensible heat factor; Grand sensible heat factor; effective room sensible heat factor.

**TEXT BOOKS:**

1. Basic Refrigeration and air-conditioning by Annanthana and Rayanan, TMG

2. Refrigeration and air-conditioning by R.C.Arora, PHI

**REFERENCES BOOKS:**

1. Refrigeration and air-conditioning by C.P arora

2. Refrigeration and air-conditioning by Arora and Domkundwar, Dhanpat rai

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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| **PE-I** | **B.Tech (6th Sem) Mechatronics Engineering** | | | | | | |
| **MTP-306A** | **Digital Image Processing** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students well versed in the fundamentals of Digital Image Processing.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO1** | **Students will be able to understand the fundaments terminologies of images and pixels.** | | | | | | |
| **CO 2** | **Students will be able to understand the concepts of Image enhancement and compression.** | | | | | | |
| **CO 3** | **Students will be able to elaborate the Image restorations and segmentation.** | | | | | | |
| **CO 4** | **Students will be able to attain knowledge about Boundary Representations and recognition.** | | | | | | |

**UNIT-I**

**Digital image fundamentals:** Introduction, image model, sampling and Quantization, relationship between pixels, imaging geometry, discrete, Fourier transform, properties of two dimensional Fourier transform, fast Fourier transform.

**UNIT-II**

**Image enhancement and compression:** Enhancement by point processing, spatial filtering and enhancement in the frequency domain, pseudo color image processing, image compression models, error free compression, image compression standards.

**UNIT-III**

**Image restorations:** Degradation, models, diagonalizations of matrices, inverse filtering, interactive restorations, geometric transformations.

**Image segmentation**: Detection of discontinuities, edge linking and boundary detection, thresholding, region orienting segmentation.

**UNIT-IV**

**Representations and recognition:** Boundary representation, Chain Code, Polygonal approximation, signature, boundary segments, Boundary description, Shape number, Fourier Descriptor, moments- Regional Descriptors –Topological feature, Texture – Patterns and Pattern classes

**TEXT BOOKS:**

1. Rafael c. Gonzalez and Richard E. Woods, digital image processing, Addison Wesley publishing company, 1987

**REFERENCES:**

1. William K. Pratt, digital image processing, John Wiley and sons, 1978

2. Jain, Fundamentals of digital image processing, PHI, 1996

3. Barrie W. Jervis , “digital signal processing (Pearson education India) 4. Prokis, “ digital signal processing” (PHI)

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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| **PE-II** | **B.Tech (6th Sem) Mechatronics Engineering** | | | | | | |
| **MTP-308A** | **Computer Aided Design and Manufacturing** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students acquainted with the concepts of Computer Aided Design and Manufacturing.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to explain the concepts of CAD/CAM.** | | | | | | |
| **CO 2** | **Students will be acquainting with the fundamentals of modeling.** | | | | | | |
| **CO 3** | **Students will be able to apply the concepts of Group technology.** | | | | | | |
| **CO 4** | **Students will be able to apply the concepts of Numeric control with FMS.** | | | | | | |

**UNIT-I**

**Introduction to CAD/CAM:** Historical Development, Industrial look at CAD/CAM Application of CA/CAM, Display devices, Input/ Output Devices, CPU. Introduction to CIM, Definition, Nature of Elements of CIM, CIM Wheel, Introduction to computer aided quality control, Contact and Non Conduct Inspection Method.

**UNIT-II**

**Modeling:** Wireframe modeling, Representation of curves, Parametric and non-parametric curves, straight lines, Hermite cubic splines, B splines curves. Plane surface, ruled surface, surface of revolution, bi-cubic surface, Bezier surface, B spline surface, Solid modeling, boundary representation, sweeping, parametric solid modeling.

**UNIT-III**

**Basic commands:** Introduction, Transformation of points & line, 2-D translation, rotation, Reflection, Scaling, shearing and combined transformation, Homogeneous coordinates, Orthographic and perspective Projections.

**Group technology:** Part families, Part classification and coding, Optiz method, product flow analysis, Machine cell Design, Advantages of GT.

**UNIT-IV**

**Numerical control:** Types of NC systems, MCU & other components, Co-ordinate system, NC manual part programming, G & M codes, part program for simple parts, Computer assisted part programming. **FMS:** Introduction, FMS component, Types of FMS, FMS layout, planning for FMS, advantage and applications. Introduction, conventional process planning, Steps in variant process planning, types of CAPP, planning for CAPP

**TEXT BOOKS:**

1. Chris McMahon and Jimmie Browne, CAD/CAM – Principle Practice and Manufacturing Management, Addison Wesley England, Second Edition, 2000.

2. Rogers, D.F. and Adams, A., Mathematical Elements for Computer Graphics, McGraw Hill Inc, NY, 1989

3. Ibrahim Zeid, CAD/CAM theory and Practice, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1992.

4. M.P. Groover, Automation, Productions systems and Computer-Integrated Manufacturing by Prentice – Hall

**REFERENCE BOOKS:**

1. Ibrahim Zeid, Mastering CAD/CAM, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

2. P. Radhakrishnan, S. Subramanayan and V.Raju, CAD/CAM/CIM, New Age International (P) Ltd., New Delhi.

3. Groover M.P. and Zimmers E. W., CAD/CAM: Computer Aided Design and Manufacturing, Prentice Hall International, New Delhi, 1992.

4. Dr. Sadhu Singh, Computer Aided Design and Manufacturing, Khanna Publishers, New Delhi, Second Edition, 2000.

5. Chang, Wang &Wysk Computer Aided Manufacturing. Prentice Hall

6. Kundra &Rao, Numerical Control and Computer Aided Manufacturing by, Rao and Tiwari, Tata Mc-Graw Hill.

7. Mattson, CNC programming Principles and applications, Cengage Learning India Pvt. Ltd. Delhi

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit.*

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| **PE-II** | **B.Tech (6th Sem) Mechatronics Engineering** | | | | | | |
| **MTP-310A** | **Microcontrollers** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students knowledgeable about the fundamentals of Microcontrollers.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to evaluate the microcontroller** | | | | | | |
| **CO 2** | **Students will be able to explain the fundamentals of Timer Programming and interrupts.** | | | | | | |
| **CO 3** | **Students will be able to make program of Microcontroller.** | | | | | | |
| **CO 4** | **Students will be able to elaborate the concepts of interfacing of microcontroller.** | | | | | | |

**UNIT-I**

**Introduction**: - Evaluation of Microcontrollers; Classification of Microcontroller; Comparison between Microprocessor and Microcontrollers; Overview of 8051 microcontroller family. Block Diagram, Architecture and pin description of 8051. ; Types of Registers and flags of 8051.

**UNIT-II**

**Introduction to programming of Microcontroller**: - 8051 Instruction Format, Addressing modes, Data transfer instructions; Logical operations, Arithmetic operations, looping, jump and call instructions, Programming in C.

**UNIT-III**

**Timer Programming and interrupts** :- 8051 timer Programming ; 8051 Serial port programming; 8051 interrupt programming; External memory interfacing.

**UNIT-IV**

**Interfacing of microcontroller** :- LCD , Keyboard interfacing ; A/D , D/A and sensor interfacing; Microcontroller interfacing with a) Relays b) opto-isolators , c) stepper motor d) DC motor

**TEXT BOOKS:**

1. Muhammad Ali Mazidi., “The 8051 Microcontroller And Embedded Systems Using Assembly And C” , Pearson , 2 nd edition

2. Kenneth J. Ayala , “The 8051 Microcontroller” .

**REFERENCES:**

1. Mackenzie , “The 8051 Microcontroller” , Pearson Education.

2. Ghoshal Subrata , “8051 Microcontroller: Internals, Programming & Interfacing”, Pearson Education..

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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| **PE-II** | **B.Tech (6th Sem) Mechatronics Engineering** | | | | | | |
| **MTP-312A** | **Automobile Engineering and Autotronics** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students well versed in the fundamentals of Automobile Engineering and Autotronics.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to explain the concept of Automobile.** | | | | | | |
| **CO 2** | **Students will be able to elaborate the fundamentals of brakes.** | | | | | | |
| **CO 3** | **Students will be able to understand the working of gear box.** | | | | | | |
| **CO 4** | **Students will be able to explain Steering Geometry.** | | | | | | |

**UNIT-I**

**INTRODUCTION:** Brief history of automobiles, Main components of an automobile, Brief description of each component. Brief description of constructional details and working of a four stroke I.C. Engine (S.I. Engines and C.I. Engines) including lately developed overhead cam shaft, Multi-cylinder engines, Introduction to recent developments in I.C. Engines- Direct injection systems, Multi-point fuel injection systems, Introduction, Brief description of different components of Transmission System. CLUTCH: Clutch Introduction to Clutch and its different types, Principle of Friction Clutch, Clutch Lining and friction materials used in Friction Clutches, Torque transmitted, Brief description of Cone Clutch, Single Plate and Multiplate Clutches, Dry and wet clutches, Automatic clutch action, Centrifugal clutches, Electromagnetic clutches, Fluid Flywheel.

**UNIT-II**

**GEAR BOX:** Gear Box Air resistance, gradient resistance and rolling resistance coming across a moving automobile, Tractive effort, Variation of tractive effort with speed, Performance curves (object and need of a gear box), Sliding mesh gear box, Control mechanism, Sliding type selector mechanism, Ball type selector mechanism, Steering column gear shift control, Constant mesh gear box, Synchromesh device, Automatic transmission in general, AP automatic gear box, Torque converter, Torque converter with direct drive, Lubrication of Gear Box. PROPELLER SHAFT: Functions and requirements of a propeller shaft, Universal joints, Constructional forms of universal joints, Flexible-ring joints, Rubber-bushed flexible joints. Constant-velocity joints. Differential : Principle of operation, Constructional details of a typical Differential unit, Traction control differentials, Multi-plate clutch type traction control device.

**UNIT-III**

**BRAKES:** Functions and methods of operation, Brake efficiency. Elementary theory of shoe brake, brake shoe adjustments, A modern rear-wheel brake, Disc brakes, Brake linkages, Leverage and adjustment of the brake linkage, Servo- and power operated brakes, Vacuum brake operation,' Hydraulic Brakes-constructional details and working, Direct action vacuum servos, Power-operated brakes, A dual power air brake system, Suspension system Suspension principles, Road irregularities and human susceptibility, Suspension system, Damping, Double tube damper, Single tube damper, Lever arm type damper, Springs-Leaf springs, Coil and torsion springs, variable rate springs, Composite leaf springs, Rubber springs, Air springs, Adjustable and self-adjusting suspensions, Interconnected suspension system, Interconnected air and liquid suspensions, Independent suspension system, Different independent suspension layouts, McPherson strut type, Rear suspension-live axle, McPherson strut rear suspension.

**UNIT-IV**

**Steering Geometry:** Castor, Camber, Kingpin inclination, Combined angle, Toe-in, Steering system-basic aims, Ackerman linkage, Steering linkages for independent suspension, Center point steering, Costarring or trailing action, Cornering power, Self-righting torque, Steering characteristics-over steer and under steer, Axle beam, Stub-axle construction, Steering column, Reversible and irreversible steering, Rack-and-pinion steering mechanism, Effect of toe-in on steering, Power steering, Vickers System.

**TEXT BOOKS:**

1. The Motor Vehicle - By Newton, Steeds and Garretle Basic

2. Automobile Engineering - By Kirpal Singh

**REFERENCES:**

1. Automobile Engineering \*' -By K.M. Gupta, Umesh Publications

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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|  | **B.Tech (6th Sem) Mechatronics Engineering** | | | | | | |
| **MTC-306LA** | **Embedded Systems-II Lab** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **-** | **-** | **3** | **1.5** | **60** | **40** | **100** | **3h** |
| **Purpose** | **To make students acquainted with experiments of Embedded Systems-II.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to understand the basic pin diagram and architecture of ATMEGA 2560.** | | | | | | |
| **CO 2** | **Students will be able to work with Motion control with PWM.** | | | | | | |
| **CO 3** | **Students will be able to perform experiments with Servo motor control and sensor switching.** | | | | | | |
| **CO4** | **Students will be able to interface the sensors along with LCD to the ATMEGA 2560.** | | | | | | |

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**LIST OF EXPERIMENTS:**

1. Study of architecture of ATMEGA 2560.
2. Study of Pin diagram of ATMEGA 2560.
3. Adding two numbers using ATMEGA 2560 with different possible operations.
4. Interfacing of Beep and Buzzer with ATMEGA 2560.
5. I-O interfacing with ATMEGA 2560.
6. Motion control with ATMEGA 2560.
7. Motion control with PWM
8. LCD interfacing with ATMEGA 2560.
9. Sensor Switching with ATMEGA 2560.
10. Servo Motor Control using PWM
11. Timer overflow interrupt with ATMEGA 2560.
12. ADC sensor display on LCD with ATMEGA 2560.

**NOTE:** Student will be required to perform total of 10 experiments. 8 experiments will be from the below given list and rest experiments will be designed based upon the curriculum

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|  | **B.Tech (6th Sem) Mechatronics Engineering** | | | | | | |
| **MTC-308LA** | **Pneumatic and Hydraulic Instrumentation Lab** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **-** | **-** | **3** | **1.5** | **60** | **40** | **100** | **3h** |
| **Purpose** | **To make students well versed in the fundamentals of Pneumatic and Hydraulic Instrumentation.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to demonstrate the concepts of Hydraulic and pneumatic circuit.** | | | | | | |
| **CO 2** | **Students will be able to perform experiments on synchronizing circuit.** | | | | | | |
| **CO 3** | **Students will be able to work with sequential circuit.** | | | | | | |
| **CO 4** | **Students will be able to know the concepts of PLC.** | | | | | | |

**NOTE:** Student will be required to perform total of 10 experiments. 7 experiments will be from the below given list and rest experiments will be designed based upon the curriculum.

**LIST OF EXPERIMENTS:**

**Study and experiment the following circuits.**

1. Basic Hydraulic circuit

2. Meter in & Meter out hydraulic circuit

3. Basic pneumatic circuit

4. Meter in & Meter out pneumatic circuit

5. Regenerative circuit.

6. Electro pneumatic circuit

7. Synchronizing circuit

8. Automatic Reciprocation circuit

9. Sequential circuit

10. Automatic Reciprocation of Double acting cylinder using PLC

11. Fluid power circuits using Automation studio software.

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|  | **B.Tech (6th Sem) Mechatronics Engineering** | | | | | | |
| **MTC-310LA** | **Project II** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **-** | **-** | **6** | **3** | **100** | **0** | **100** | **3h** |
| **Purpose** | **To be able to apply some of the techniques/principles that have been taught to carry out time and budget planning for the project.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to demonstrate thorough and systematic understanding of project contents.** | | | | | | |
| **CO 2** | **Students will understand methodologies and professional way of documentation and communication.** | | | | | | |
| **CO 3** | **Students will be able to attain knowledge of the key stages in development of the project** | | | | | | |
| **CO 4** | **Students will able to implement presentation techniques in their work style** | | | | | | |

The student is expected to finish the remaining portion of the project. The project will be individual practical and investigative, requiring the student to investigate the existing background, theories and knowledge as applied to a problem in the design and/or operation of an existing or new process or product. By practical measurement, design, implementation and above all, creativity, the student will arrive at a solution based on sound engineering principles worked in previous semester. The project will be integrative, deploying and extending the range of skills and knowledge previously and concurrently developed.

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| **Open Elective-I** | **B.Tech (7th Sem) Mechatronics Engineering** | | | | | | |
| **MTO-401A** | **Applied Numerical Techniques and Computer Programming** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students conversant with the fundamentals of Applied Numerical Techniques and Computer Programming .** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to explain the concepts of Interpolation and Curve Fitting.** | | | | | | |
| **CO 2** | **Students will understand the fundamentals of Non-Linear Equations.** | | | | | | |
| **CO 3** | **Students will be able to apply the concepts of Ordinary Differential Equations.** | | | | | | |
| **CO 4** | **Students will be able to apply the concepts of Partial Differential Equations.** | | | | | | |

**UNIT-I**

**Interpolation and Curve Fitting:** Lagrangian Polynomials, Divided differences, Interpolating with a cubic spline, Bezier Curves and B-Spline Curves, Polynomial approximation of surfaces, Least Square approximations, Flow Chart for Computer Programmes.

**UNIT-II**

**Solving Non-Linear Equations:** Bisection Method, Linear Interpolation Methods, Newton‟s Methods, Muller‟s Methods, Fixed-point Iteration Method, Flow Chart for Computer Programmes. Solving Sets of Equations: The Elimination Method, Gauss and Gauss Jordan Methods, Other Direct Methods, Iterative Methods, The Relaxation Methods, Flow Chart for Computer Programmes.

**UNIT-III**

**Numerical Differentiation and Integration:** Derivatives from difference tables. High Order Derivative, Extra-polation Techniques. The Trapezoidal Rule, Simpson‟s Rules. Flow Chart for Computer Programmes.

**Numerical Solution of Ordinary Differential Equations:**The Taylor-Series Method, Euler and modified Euler methods,Range-Kutta methods,Miline‟s Method.The adams-Moulton method, Convergence Criteria, Errors and error Propagation. Flow Chart for Computer Programmes.

**UNIT-IV**

**Numerical Solution of Ordinary and Partial Differential Equations**: Taylor series method, Euler and modified Euler method, Runge Kutta methods, Milne‟s method, Finite differences approximations of partial derivatives,Solution of Laplace equation(Elliptic)by standard5– point formula, solution of one dimensional heat equation(Parabolic)by Bender-Schmidt method, crank–Nicolson method, Solution of one dimensional wave equation(Hyperbolic) by iterative method.

**TEXT BOOKS:**

1. Applied Numerical Analysis by Curtis f. Gerald and Patrick O. Wheatley – Published by Addison Wesley.

2. Introductory Methods of Numerical Methods – S.S. Sastry, PHI, New Delhi.

3. Numerical Method: E. Balagurusamy, Tata McGraw Hill Publication.

**REFERENCES:**

1. MATHEMATICA – A system for doing mathematics by Computer by Wolfram, Stephen – Published by Addition – Wesley.

2. Applied Numerical Methods by Camahan, Brice,Et.al, Published by Wiley, York.

3. Numerical Solution of partial differential equations by Smith, G.D. Published by Oxford University Press London.

4. Iterative Methods for the solution of Equations by J.F. Traub – Published by Prentice Hall.

5. Numerical Methods in Engineering and Science by B.S. Grewal- Published by Khanna Publishers.

6. Numerical Methods in Engineering by M.G. Salvadori and M.L. Baron- Published by Prentice Hall India.

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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| **Open Elective-I** | **B.Tech (7th Sem) Mechatronics Engineering** | | | | | | |
| **MTO-403A** | **Non Destructive Testing** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students conversant with the fundamentals of Non Destructive Testing .** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will able to understand NDET and NDT techniques.** | | | | | | |
| **CO 2** | **Students will be able to apply the concepts of Radiographic testing.** | | | | | | |
| **CO 3** | **Students will be able to apply the concepts of Eddy current testing and ultrasonic testing.** | | | | | | |
| **CO 4** | **Students will be able to analyze various defects in materials** | | | | | | |

**UNIT-I**

**Introduction to NDET and surface NDT techniques**: Introduction to non-destructive testing and evaluation, visual examination, liquid penetrant testing and magnetic particle testing. Advantages and limitations of each of these techniques.

**UNIT-II**

**Radiographic testing:** Radiography principle, electromagnetic radiation sources, X-ray films, exposure, penetrometer, radiographic imaging, inspection standards and techniques, neutron radiography. Radiography applications, limitations and safety.

**UNIT-III**

**Eddy current testing and ultrasonic testing:** Eddy current principle, depth of penetration, eddy current response, eddy current instrumentation, probe configuration, applications and limitations. Properties of sound beam, ultrasonic transducers, inspection methods, flaw characterization technique, immersion testing. Special/Emerging Techniques Leak testing, Acoustic Emission testing, Holography, Thermography, Magnetic Resonance Imaging, Magnetic Barkhausen Effect. In-situ metallography

**UNIT-IV**

Defects in materials / products and Selection of NDET Methods: Study of defects in castings, weldments, forgings, rolled products etc. and defects arising during service. Selection of NDET methods to evaluate them. Standards and codes.

**TEXT BOOKS:**

1. Baldevraj, Jayakumar T., Thavasimuthu M., (2008) “Practical Non-Destructive Testing”, 3rd edition, Narosa Publishers. Reference Books

2. American Society for Metals, “Non-Destructive Evaluation and Quality Control”: Metals Hand Book: 1992, Vol. 17, 9th Ed, Metals Park, OH.

3. Paul E Mix, “Introduction to nondestructive testing: a training guide”, Wiley, 2nd edition New Jersey, 2005.

**REFERENCES BOOKS:**

1. Ravi Prakash, “Non destructive Testing Techniques”, New Age International Publishers, 1st rev. edition, 2010.

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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| **Open Elective-I** | **B.Tech (7th Sem) Mechatronics Engineering** | | | | | | |
| **MTO-405A** | **Internet of Things** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students acquainted with the concepts of Internet of Things.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to explain IoT, Network and communication aspect.** | | | | | | |
| **CO 2** | **Students will be able to analyze the challenges in IoT.** | | | | | | |
| **CO 3** | **Students will be able to attain the knowledge about python.** | | | | | | |
| **CO 4** | **Students will be able to explain Developing IoTs.** | | | | | | |

**UNIT-I**

**Introduction to IoT** Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs

IoT & M2M: Machine to Machine, Difference between IoT and M2M, Software define Network

**UNIT-II**

**Network & Communication aspects** Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination

**UNIT-III**

**Challenges in IoT** Design challenges, Development challenges, Security challenges, Other challenges

**Domain specific applications of IoT** Home automation, Industry applications, Surveillance applications, Other IoT applications

**UNIT-IV**

**Developing IoTs** introduction to python, introduction to different iot tools, developing applications through iot tools, developing sensor based application through embedded system platform, implementing iot concepts with python

**TEXT BOOKS:**

1. Vijay Madisetti, Arshdeep Bahga, “Internet of Things: A Hands-On Approach”
2. Waltenegus Dargie,Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice"

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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| **PE-III** | **B.Tech (7th Sem) Mechatronics Engineering** | | | | | | |
| **MTP-401A** | **Advanced Manufacturing Technology** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students knowledgeable about the Advanced Manufacturing Technology.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to understand the concepts of Machining and metal forming.** | | | | | | |
| **CO 2** | **Students will be able to elaborate the fundamentals of Polymer, plastics and thread manufacturing.** | | | | | | |
| **CO 3** | **Students will be able to analyze the composites and laminates.** | | | | | | |
| **CO 4** | **Students will be able to elaborate the fundamentals of thread manufacturing.** | | | | | | |

**UNIT-I**

**Machining:** Hot machining, Machining of Plastics, Unit heads, Plastics cooling, electro forming, Surface Cleaning and Surface Treatments, Surface Coatings, Paint Coating and Slushing, Adhesive Bonds, Adhesive Bond Joints, Adhesives, Surface Coating for Tooling, Graphite Mould Coating, Vacuum Mould Process.

**UNIT-II**

**Polymers and plastics:** Introduction, Polymers, Polymerization, Addition of Polymers, Plastics, Types of plastics, Properties of Plastics, Processing of Thermoplastic Plastics, Injection Moulding, Extrusion Process, Sheet forming processes, Processing of Thermosetting Plastics, Compression Moulding, Transfer Moulding, Casting of Plastics, Machining of plastics, other processing methods of plastics

**Thread Manufacturing:** Introduction, casting, thread chasing, Thread Rolling, Die Threading and Tapping, Thread Milling, Thread Measurement and Inspection

**UNIT-III**

**Metal formimg:** Theoretical basis of metal forming, classification of metal forming processes, cold forming, hot working, Warm working, Effect of variables on metal forming processes, Methods of analysis of manufacturing processes, Open Die forging, Rolling Power Rolling, Drawing, Extrusion.

**UNIT-IV**

**Composites and laminates:** Introduction, Types of Composites materials, Agglomerated Materials, Reinforced materials, Laminates, Surface Coated Materials, Production of Composite Structures, Fabrication of particulate composite Structures, Fabrication of reinforced Composite, Fabrication of Laminates, Machining, Cutting and Joining of Composites.

##### TEXT BOOKS:

1. Principles of Manufacturing By J.S.Campbell, Tata McGraw-Hill
2. Production Engineering Sciences By Pandey and Sinh Standard Pub.
3. A text book of Production Technology By P.C. Sharma S.Chand & Company.

##### REFERENCE BOOKS:

1. Manufacturing Materials and Processes By Lindberg Prentice Hall
2. A text book of Production Engineering By P.C. Sharma S.Chand & Company.
3. Manufacturing Technology Manufacturing Science by A.Ghosh, East-West Publications. By

Radhakrishnan, Scitech

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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| **PE-III** | **B.Tech (7th Sem) Mechatronics Engineering** | | | | | | |
| **MTP-403A** | **Finite Element Methods** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students well versed in Finite Element Methods.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to explain the Model boundary value problem.** | | | | | | |
| **CO 2** | **Students will be able to apply the fundamentals of External and internal equilibrium.** | | | | | | |
| **CO 3** | **Students will be able to attain knowledge of Weighted residual methods.** | | | | | | |
| **CO 4** | **Students will be able to attain knowledge of weighted integral forms.** | | | | | | |

**UNIT-I**

**Basic Concept:** Historical background, Engineering applications, general description, Comparison with other methods. **Need for weighted-integral forms:** Relevant mathematical concepts and formulae, weak formulation of boundary value problems, variational methods, Rayleigh-Ritz method, and weighted residual approach.

**UNIT-II**

**Model boundary value problem:** Finite element discretization, element shapes, sizes and node locations, interpolation functions, derivation of element equations, connectivity, boundary conditions, FEM solution, post-processing, compatibility and completeness requirements, convergence criteria, higher order and isoparametric elements, natural coordinates, Langrange and Hermite polynomials.

**UNIT-III**

**External and internal equilibrium equations**: one-dimensional stress-strain relations, plane stress and strain problems, axis-symmetric and three dimensional stress-strain problems, strain displacement relations, boundary conditions, compatibility equations, computer programs.

**UNIT-IV**

**Weighted residual methods:** Galerkin FE formulation – axially loaded bar – heat flow in a bar. Isoparametric formulation: Natural coordinates – linear and quadratic bar element – linear triangle and plane bilinear elements for scalar fields – jacobian matrix – element matrices - Gauss quadrature – requirements for isoparametric elements – accuracy and mesh distortion. Advanced topics: Introduction to non-linear and dynamic finite element procedures, error estimation, coupled problems (only brief details are needed).

**TEXT BOOKS:**

1. The Finite Element Method By Zienkiewicz, Tata McGraw

**REFERENCES:**

1. The Finite Element Method for Engineers By Huebner, John Wiley

2. An Introduction to the Finite Element Method By J.N.Reddy, McGraw Hill

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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| **PE-III** | **B.Tech (7th Sem) Mechatronics Engineering** | | | | | | |
| **MTP-405A** | **Smart Materials** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students proficient in the fundamentals of Smart Materials.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to attain knowledge about Smart and intelligent Materials** | | | | | | |
| **CO 2** | **Students will be able to explain smart materials and structural systems.** | | | | | | |
| **CO 3** | **Students will be able to understand the concepts of Electrorheological Fluids** | | | | | | |
| **CO 4** | **Students will be able to elaborate Piezoelectric Materials** | | | | | | |

**UNIT-I**

**Smart materials:** Introduction, Historical Perspective, Overview of Microsystems and Smart Systems, Need for Miniaturization, Role of Microfabrication, Typical applications of Microsystems and Smart Systems.

**Intelligent materials**: Structural Materials, Functional Materials, Primitive functions of Intelligent Materials, Intelligence inherent in Materials, Materials Intelligently Harmonizing with Humanity, Intelligent Biological Materials.

**UNIT-II**

**Smart Materials and Structural Systems:** The principal ingredients of a premier class of smart materials, Actuator Materials, Sensing Technologies, Micro-sensors, Intelligent Systems, Hybrid Smart Materials, Passive Sensory Smart Structures, Reactive actuator based Smart Structures, Active Sensing and Reactive Smart Structures. Smart Skins, Synthesis of Future smart systems.

**UNIT-III**

**Electrorheological Fluids:** Suspension and Electro-rheological fluids, The Electro-Rheological Phenomenon, Charge Migration mechanism for the dispersed phase, Electrorheological Fluid Actuators, Experimental investigations.

**UNIT-IV**

**Piezoelectric Materials:** Introduction, Basic Principle, History, Classification of Dielectric materials, Important Dielectric Parameters, Electrostrictive effect, Piezoelectric Effect, Pyroelectric Effect, Ferroelectric Materials, Poling. Examples of Piezoelectric Materials: Quartz, Lead Zirconate Titanate(PZT), Fabrication of PZT, Polymer Piezoelectric Materials, Barium Titanate, Zinc Oxide Thin Films, Polymer Composites.

**Engineering Applications of Piezoelectric Materials:** Gas Lighter, Pressure Sensor, Accelerometer, Piezoelectric Gyroscope, Piezoelectric Microphone, Piezoelectric Actuators, Piezoelectric Motor, Piezoelectric Transformer

**TEXT BOOKS:**

1. Smart Materials and Structures by B.V. Gandhi and B.S. Thompson, Chapman and Hall Pub.

2. Smart Materials Edited by Mel Schwartz , CRC Press.

3. Smart Structures Analysis and Design by A.V. Srinivasan and D. Michael McFarlaid, Cambridge University Press.

4. Piezoelectric Materials and Devices: Applications in Engineering and Medical Sciences by M.S. Vijaya, CRC Press.

**REFERENCES:**

1. Smart Structures and Materials by Brian Culshaw, Artech House.

2. Smart Structures by Gauenzi, P., Wiley Publication. 3. Piezoelectricity by Cady, W. G., Dover Publication.

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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| **PE-IV** | **B.Tech (7th Sem) Mechatronics Engineering** | | | | | | |
| **MTP-407A** | **Renewable Energy Resources** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students well versed in the concepts of Renewable Energy Resources.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to explain direct energy conversion method.** | | | | | | |
| **CO 2** | **Students will be able to apply the concepts of** **Extraterrestrial solar radiation.** | | | | | | |
| **CO 3** | **Students will be able to apply the concepts of photo electric energy.** | | | | | | |
| **CO 4** | **Students will understand the concepts of hydro power.** | | | | | | |

**UNIT-I**

**Direct energy conversion:** Description, working principle, magneto hydrodynamic systems (MHD), thermoelectric generators, thermionic generator, fuel cells, EMF generated, power output, losses and efficiency, applications, hydrogen conversion and storage systems.

**UNIT-II**

**Extraterrestrial solar radiation: C**omponents of radiation, geometry of earth and sun, geometry of collector arid the solar beam, effects of earth's atmosphere, measurements of solar radiation, calculation of heat balance for a solar collector, type of water heaters, selective surfaces, crop heaters, space heating, space cooling, water desalination, solar ponds, solar concentrators, electric power system, problems.

**UNIT-III**

**Photo electric energy:** Introduction, the silicon p-n junction, photon absorption solar radiation input, photovoltaic circuit properties and loads, limits to cell efficiency, solar cell construction type and adaptations of photovoltaic, other types of photoelectric and thermo electric generation, problems.

**UNIT-IV**

**Hydro power:** Principles of hydro power, assessing the resource for small installations, an impulse turbine, reaction turbines, hydro electric systems, the hydraulic rain pump, wind turbine types and terms, linear momentum and basic theory, dynamic matching, steam tube theory, characteristics of the wind, power extraction by a turbine, electricity generation, mechanical power, problems.

**TEXT BOOKS:**

1. Non-Conventional energy sources by Rai G D, Khanna Publishers, NewDelhi
2. Non-Conventional energy resources by BH Khan, Mc Graw Hill

**REFERENCE BOOKS:**

1. Renewable Energy Rsources by John W. Twidell and Anthony D. Weir, published by E.& F. N. Spon Ltd.London.

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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| **PE-IV** | **B.Tech (7th Sem) Mechatronics Engineering** | | | | | | |
| **MTP-409A** | **Computational Fluid Dynamics** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students knowledgeable about the fundamentals of Computational Fluid Dynamics.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to apply the methods of prediction.** | | | | | | |
| **CO 2** | **Students will be able to explain the concepts of steady one dimensional conduction.** | | | | | | |
| **CO 3** | **Students will understand the concepts of discretisation .** | | | | | | |
| **CO 4** | **Students will be able to analyze CFD code.** | | | | | | |

**UNIT-I**

**Methods of prediction:** Comparison of experimental investigation Vs theoretical calculation; Mathematical description of physical phenomena; significance of governing differential equations; the general form of governing differential equation.

**Classification of problems:** Physical classification: Equilibrium problems and Marching problems; Mathematical classification: Elliptic, parabolic and hyperbolic partial differential equations; Nature of co-ordinates; one way and two-way co-ordinates; Proper choice of co- ordinates.

**UNIT-II**

**The concept of discretisation:** Finite differences; Taylor series formulation; Finite difference discretisation of ordinary and partial derivatives; Truncation error, round-off error, discretisation error; Consistency and stability of numerical schemes; Variation formulation; Method of weighted Residuals, control volume formulation.

**UNIT-III**

**Steady one- dimensional Conduction:** The inter-face conductivity, Non linearity, Source- Term Linearization, Types of Boundary Conditions. Unsteady one-dimensional Conduction: Explicit, Crank-Nicolson and Fully Implicit scheme's Discretisation of two and three- dimensional problems, Stability analysis.

**UNIT-IV**

**CFD code:** The basic structure of a CFD code: Pre-processor, Solver and Postprocessor, User-defined subroutines, Solution to some basic problems in heat transfer and fluid flow.

**TEXT BOOKS:**

1. Computational Fluid Dynamics By Anderson, McGraw-Hill
2. Numerical Heat Transfer and fluid flow By Patankar, McGraw-Hill

**REFERENCES:**

1 . An Introduction to Computational Fluid Dynamics: The Finite Volume Method by H. Versteeg, Pearson.

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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| **PE-IV** | **B.Tech (7th Sem) Mechatronics Engineering** | | | | | | |
| **MTP-411A** | **Consumer electronics** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students acquainted with the concepts of Consumer electronics .** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to explain Audio system.** | | | | | | |
| **CO 2** | **Students will be able to explain video system.** | | | | | | |
| **CO 3** | **Students will be able to understand the working of Electronic Gadgets.** | | | | | | |
| **CO 4** | **Students will be able to attain the knowledge of Home appliances.** | | | | | | |

**UNIT-I**

**Audio System:** Wave motion, Microphones, Headphones and Headsets, Loudspeakers, Acoustics, Disc recording and Distortion in disc and tape, Optical recording and reproduction, Control circuits, Amplifying systems, Portable stereo, Theatre sound system and AM/FM tuners.

**UNIT-II**

**Video Systems:** Monochrome TV standards and systems, Colour TV standards and systems, Monochrome and colour TV controls, Video Tape recording and reproduction, video disc recording and playback, Remote controls and Video systems.

**UNIT-III**

**Electronic Gadgets:** Telecommunication Systems, Switching Systems, Modulation techniques, Fiber optics, Mobile Systems, Xerography and Fascimile fax, Automated Teller Machines and Top Boxes.

**UNIT-IV**

**Home Appliances:** Digital clocks, In-Car Computers, Microwave ovens, Washing Machines, Air Conditioners and Refrigerators.

**TEXT BOOKS:**

1. Consumer Electronics By S.P. Bali, Pearson Education, 1st edition.
2. Colour Television-principles & practice R.R Gulati by Wiley Eastern Limited, New Delhi.

**REFERENCES:**

1. Colour Television & Video Technology by A.K. Maini CSB Publisher
2. VCR-principles, maintenance & repair by S.P. Sharma, Tata Mc Graw Hill, New Delhi
3. Colour TV by A. Dhak.

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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|  | **B.Tech (7th Sem) Mechatronics Engineering** | | | | | | |
| **MTC-401A** | **Robotics and Automation** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students well versed with the concepts of Robotics and Automation.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to attain the knowledge of Automation and robots.** | | | | | | |
| **CO 2** | **Students will be able to analyze inverse kinematics problems.** | | | | | | |
| **CO 3** | **Students will understand the workplace analysis.** | | | | | | |
| **CO 4** | **Students will apply the concept of Lagrange's equation.** | | | | | | |

**UNIT-I**

**Automation and robots:** Robot classification, Applications, Robot specifications, Dot and Cross products, Coordinate frames, Homogeneous coordinates, Link Coordinates, The arm equation, Five-axis articulated robot (Rhino XR-3), Four-axis SCARA robot (Adept One), Six-axis articulated robot (Intelledex 660).

**UNIT-II**

**The inverse kinematics problem:** General properties of solutions, Tool Configuration, Inverse kinematics of Five-axis articulated robot (Rhino XR- 3), Inverse Kinematics of Four- axis SCARA robot (Adept One), inverse kinematics of Six- axis articulated robot (Intelledex 660), and Inverse kinematics of a three-axis planar articulated robot, a robotic work cell.

**UNIT-III**

**Workspace analysis:** Work envelope of a five-axis articulated robot (Rhino XR-3), Work envelope of a four-axis SCARA robot (Adept One), Workspace fixtures, The pick and place operations, Continuous path motion, Interpolated motion, Straight line motion. The tool configuration and Jacobean matrix, Joint space singularities, Generalized inverses, Resolved motion rate controls, rate control of redundant robots, rate control using (1) inverses, The manipulator Jacobean, Induced joint torque and forces.

**UNIT-IV**

**Lagrange's equation:**  Kinetic and potential energy, Generalized force, Lagrange-Euler dynamic model, Dynamic model of a two-axis planner articulated robot, Dynamic model of a three-axis SCARA robot, Direct and inverse dynamics, Recursive Newton-Euler formulation, Dynamic model of a one-axis robot (inverted pendulum).

**TEXT BOOKS:**

1. Industrial Robotics By M.P. Groover, McGraw Hill

**REFERENCE BOOKS:**

1. Industrial Robotics and Automation - By S. R. Deb Tata McGraw Hill

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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|  | **B.Tech (7th Sem) Mechatronics Engineering** | | | | | | |
| **MTC-403LA** | **Robotics and Automation Lab** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **-** | **-** | **2** | **1** | **60** | **40** | **100** | **3h** |
| **Purpose** | **To make students knowledgeable about the experiments of Robotics and Automation.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to demonstrate the stepper and DC motor.** | | | | | | |
| **CO 2** | **Students will be able to work on Pneumatic and electro-pneumatic circuits.** | | | | | | |
| **CO 3** | **Students will be able to elaborate about PLC and its application.** | | | | | | |
| **CO 4** | **Students will be able to understand the image processing technique.** | | | | | | |

**NOTE:** Student will be required to perform total of 10 experiments. 8 experiments will be from the below given list and rest experiments will be designed based upon the curriculum.

**LIST OF EXPERIMENTS:**

**Study and experiment the following circuits.**

1. Stepper motor interface.
2. Traffic light interface using a PLC kit.
3. Speed control of DC motor kit.
4. Various types of Sensors and actuators.
5. Hydraulic System.
6. Pneumatic and electro-pneumatic circuits.
7. PLC and its applications.
8. Image processing technique.
9. Automatic Reciprocation circuit
10. Automatic Reciprocation of Double acting cylinder using PLC
11. Robotic Arm
12. Various types of Transducers
13. Automatic Material handling equipment
14. Automated guided vehicles

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|  | **B.Tech (7th Sem Mechatronics Engineering)** | | | | | | |
| **MTC-405LA** | **Project III** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **-** | **-** | **8** | **4** | **100** | **100** | **200** | **3h** |
| **Purpose** | **To be able to apply some of the techniques/principles that have been taught to carry out time and budget planning for the project.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to demonstrate thorough and systematic understanding of project contents.** | | | | | | |
| **CO 2** | **Students will understand methodologies and professional way of documentation and communication.** | | | | | | |
| **CO 3** | **Students will be able to attain knowledge of the key stages in development of the project** | | | | | | |
| **CO 4** | **Students will be able to implement presentation techniques in their work style** | | | | | | |

The project will be **individual** practical and investigative, requiring the student to investigate the existing background, theories and knowledge as applied to a problem in the design and/or operation of an existing or new process or product. By practical measurement, design, implementation and above all, creativity, the student will arrive at a solution based on sound engineering principles worked in previous semester. The project will be integrative, deploying and extending the range of skills and knowledge previously and concurrently developed.

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|  | **B.Tech (7th Sem) Mechatronics Engineering** | | | | | | |
| **MTC-407A** | **Industrial Training – III** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **2** | **-** | **-** | **-** | **-** | **100** | **100** | **-** |
| **Purpose** | **To provide comprehensive learning platform to students where they can enhance their employ ability skills and exposure to the industrial environment.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Capability to acquire and apply fundamental principles of engineering.** | | | | | | |
| **CO 2** | **Become updated with all the latest changes in technological world.** | | | | | | |
| **CO 3** | **Capability and enthusiasm for self-improvement through continuous professional development and life- long learning** | | | | | | |
| **CO 4** | **Awareness of the social, cultural, global and environmental responsibility as an engineer.** | | | | | | |

Student will submit summer training report of 5 to 6 week industrial training for his/her assessment. The evaluation will be made based upon the report submitted by student and presentation of work done in industry during the specified period.

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|  | **B.Tech (8th Sem Mechatronics Engineering)** | | | | | | |
| **MTC-402LA** | **Project IV** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **-** | **-** | **10** | **5** | **100** | **100** | **200** | **3h** |
| **Purpose** | **To be able to apply some of the techniques/principles that have been taught to carry out time and budget planning for the project.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to demonstrate thorough and systematic understanding of project contents.** | | | | | | |
| **CO 2** | **Students will understand methodologies and professional way of documentation and communication.** | | | | | | |
| **CO 3** | **Students will be able to attain knowledge of the key stages in development of the project** | | | | | | |
| **CO 4** | **Students will be able to implement presentation techniques in their work style** | | | | | | |

The project will be **individual** practical and investigative, requiring the student to investigate the existing background, theories and knowledge as applied to a problem in the design and/or operation of an existing or new process or product. By practical measurement, design, implementation and above all, creativity, the student will arrive at a solution based on sound engineering principles worked in previous semester. The project will be integrative, deploying and extending the range of skills and knowledge previously and concurrently developed.

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| **Open Elective-II** | **B.Tech (8th Sem Mechatronics Engineering)** | | | | | | |
| **MTO-402A** | **Sound and Noise Control** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students acquainted with the fundamentals of Sound and Noise with their control.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to explain concepts of sound and noise.** | | | | | | |
| **CO 2** | **Students will be able to understand how to control the noise.** | | | | | | |
| **CO 3** | **Students will be able to apply the technology of reducing motor vehicle noise.** | | | | | | |
| **CO 4** | **Students will be able to attain the knowledge about the personal safety devices.** | | | | | | |

**UNIT-I**

**Basic concepts of Sound and Noise:** Introduction, sound, loudness and loudness level, noise sources and levels, effect of noise on hearing, noise from equipment, noise control measures. Noise and its effects, audiometry, dangerous properties of noise, effect of noise on worker’s mind and output, effects of noise on human body

**UNIT-II**

**Planning to noise control:** Introduction, commercial buildings, hospitals, flats and apartments, Noise reduction: Introduction, noise reduction at source, selection of machinery, noise from radiating surfaces, reducing transmission of mechanical vibrations, noise control by absorption of reflected sound, barriers and enclosures

**UNIT-III**

**Technology of reducing motor vehicle noise:** Introduction, foreseeable trends, sources of noise in motor vehicles, engine speed effects, vehicle speed effects, noise reduction without radical changes in design, control of engine noise-The case of the diesel engine, radical changes in design, noise, safety and air pollution, Traffic noise reduction: Introduction, urban planning and road design, soundproofing and arrangement of living space

**UNIT-IV**

**Personal safety devices:** Introduction, acoustic problems, ear protector requirements. Instrumentation for noise analysis: Introduction, microphones, sound level meters, acoustical measurement, dosimeters, frequency anlysers, amplitude distribution analysers. Audiometric testing and dosimeters: audiometeric testing outside the plant, audiometric test booths and dosimeters.

**TEXT BOOKS:**

1. S C Bhatia, Textbook of Noise Pollution and its control, ATLANTIC PUBLISHERS AND DISTRIBUTORS (P) LTD
2. L Bernak and I Ver (1992) Noise and Vibration Control Engine e ring: Principles and Applications, John Wily, ISBN 0-471-61751-2

**REFERENCE BOOKS:**

1. D A Bies (2002), Engine ring Noise Control, Spoon press, ISBN 0-419-20430-X
2. B S Smith, R J Peters and S Owe n (1996), Acoustics and Noise Control, Addision-Wesley,

ISBN058088646

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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| **Open Elective-II** | **B.Tech (8th Sem Mechatronics Engineering)** | | | | | | |
| **MTO-404A** | **Lubricants and Lubrication** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students knowledgeable about the fundamentals of Lubricants and Lubrication.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to understand the terminology related to lubricants and lubrication.** | | | | | | |
| **CO 2** | **Students will be able to attain the knowledge of Mineral & Chemically modified lubricating base oils and Synthesized base oils.** | | | | | | |
| **CO 3** | **Students will be able to explain the steam and gas turbine oils.** | | | | | | |
| **CO 4** | **Students will be able to elaborate Compressor, Vacuum Pump & Refrigeration Oils** | | | | | | |

**UNIT-I**

**Terminology related to Lubricants & Lubrication**: Viscosity; Absolute & Kinematic Viscosity; Newtonian & Non -Newtonian Fluids; Viscosity Measurement; Viscosity Index; Additives; Base Stocks; Anti-Foam Agents; Anti-oxidant; Anti-Wear Agents; Aromatic agents; Role of lubricants in Asperity; Boundary Lubrication; Corrosion Inhibitor; Demulsibility; Detergent; Dielectric Strength; Diester; Dispersant; Dropping Point; Dry Running; Emulsifier; Extreme-Pressure Agent; Film Strength )Lubricity(; Hydrolytic Stability; Neutralization Number; Oxidative Stability; Paraffinic etc.

**Lubricants**: Introduction; Functions of lubricants, types and properties; Mineral Oils, Synthetic Oils, Biodegradable, Environment friendly oils; Automotive Engine Oils; Metal Working Fluids; Aviation Oils; Greases .

**UNIT-II**

**Mineral & Chemically modified lubricating base oils** Introduction; Steps Involved in production of Mineral base oils in refineries; Vacuum Distillates characteristics & Properties; Conventional refinery production of Lubricating base oils;

**Synthesized base oils** Introduction, Need, Application & Uses, Classification, Properties. Metal Working Fluid: Classification of Metal Working Fluids; Emulsions & Lubricants; Surface Active compounds in metal working fluids; rolling oils for steel; performance evaluation of steel rolling oils.

**UNIT-III**

**Introduction;** Dry friction; Boundary lubrication; Hydrodynamic, Hydrostatic and Elasto-hydrodynamic

**lubrication;** Lubricant additives; Principles, application to rolling contact bearings, cams, Gears.

**UNIT-IV**

**Steam & Gas Turbine Oils** Classification of Turbine Oils, Properties & Functions of Turbine Oils, Viscosity, Rust & Corrosion Protection, Demulsibility, Air Release, Foam Control, Antiwear Property, Oxidation Stability, Gas Turbine Oils.

**Compressor, Vacuum Pump & Refrigeration Oils** Classification & Specifications of Compressor Oils, Functions of Compressor Oils; Lubrication of Reciprocating Compressor : Compressor Oil properties; Synthetic compressor oils; Vacuum Pump oils; Refrigeration compressor oils; requirement & specification of Refrigeration oils.

**TEXT BOOKS:**

1. Developments in Lubricant Technology – By S.P .Srivastava, Wiley

2. Mechanics and Chemistry in Lubrication -By Dorinson and Ludema , Elsevier

3. Friction and wear of Materials -By E .Robinowicz, Johan Wiley

4. Principles of Lubrication-By A .Cameron, Longmans

**REFERENCE BOOKS:**

1. Chemistry and Technology of Lubricants – By R .M .Mortier, S .T .Orszulik, Springer-

Science +Business Media, B.V.

2. Lubricant Additives :Chemistry and Applications -Second Edition edited by Leslie R .

Rudnick, CRC Press, Taylor & Francis Group.

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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| **Open Elective-II** | **B.Tech (8th Sem Mechatronics Engineering)** | | | | | | |
| **MTO-406A** | **Competitive Manufacturing Systems** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students conversant with the fundamentals of Competitive Manufacturing Systems.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to attain the knowledge about manufacturing in a competitive environment.** | | | | | | |
| **CO 2** | **Students will be able to apply Group Technology and Flexible Manufacturing System.** | | | | | | |
| **CO 3** | **Students will be able to analyze the concepts of computer software, simulation and database of FMS** | | | | | | |
| **CO 4** | **Students will be able to explain lean manufacturing.** | | | | | | |

**UNIT-I**

**MANUFACTURING IN A COMPETITIVE ENVIRONMENT:** Five areas of competitive manufacturing: cost, quality, delivery, safety/environment, and morale. Automation of manufacturing process - Numerical control - Adaptive control - material handling and movement - Industrial robots - Sensor technology - flexible fixtures - Design for assembly, disassembly and service – PLM.

**UNIT-II**

**GROUP TECHNOLOGY & FLEXIBLE MANUFACTURING SYSTEMS:** Part families - classification and coding - Production flow analysis - Machine cell design - Benefits. Components of FMS - Computer control and functions - Planning, scheduling and control of FMS - Knowledge based scheduling.

**UNIT-III**

**COMPUTER SOFTWARE, SIMULATION AND DATABASE OF FMS:** System issues - Types of software - specification and selection - Trends - Simulation and Applications - Simulation software - Manufacturing data systems - data flow - CAD/CAM considerations - Planning FMS database.

**UNIT-IV**

**LEAN MANUFACTURING:** Origin of lean production system – Customer focus – Muda (waste) – Standards – 5S system – Total productive Maintenance – standardized work –Man power reduction – Overall efficiency - Kaizen – Common layouts - Jidoka concept – Poka-Yoke (mistake proofing) - Worker Involvement– Quality circle activity - Suggestion Programmes – Hoshin Planning System (systematic planning methodology) – Lean culture – APQP – SOP – PPAP – Factories of the future.

**TEXT BOOKS:**

1. Jha, N.K., “Handbook of Flexible Manufacturing Systems ", Academic Press Inc., 1991.
2. Bhat, S. K., “Total Quality Management", Himalaya Publishing House Pvt. Ltd., 2011.
3. Groover, M.P., “Automation, Production Systems and Computer Integrated Manufacturing ", Third Edition, Prentice-Hall, 2007.
4. Kalpakjian, “Manufacturing Engineering and Technology ", Addison-Wesley Publishing Co., 1995.

**REFERENCE BOOKS:**

1. Ohno, T.T., “Production System Beyond Large-Scale production", Productivity Press (India) Pvt. Ltd. 1992.

2. Dennis, P., “Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System”, (Second edition), Productivity Press, New York, 2007.

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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| **Open Elective-III** | **B.Tech (8th Sem Mechatronics Engineering)** | | | | | | |
| **MTO-408A** | **Operation Research and Optimization Techniques** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students well versed in the fundamentals of Operation research and optimization techniques.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to apply Linear programming problems.** | | | | | | |
| **CO 2** | **Students will be able to explain the concepts of Network and decision analysis.** | | | | | | |
| **CO 3** | **Students will be able to understand queuing theory.** | | | | | | |
| **CO 4** | **Students will be able to apply transportation problems.** | | | | | | |

**UNIT-I**

**Introduction:** Definition and Development of Operations Research, Necessity and scope of OR in Industry, Operations Research in Decision making, Models in OR, Fields of application, Difficulties and Limitation of OR.

**General Linear Programming Problems**: Introduction, Maximization and minimization of function with or without Constraints, Formulation of a linear programming problem, Graphical method and Simplex method, Big M method, Degeneracy, Application of linear Programming (LPP) in Mechanical Engineering.

**UNIT-II**

**The Transportation Problems:** Mathematical formulation, Stepping stone method, Modified Distribution Method, Vogels Approximation Method, Solution of balanced and unbalanced transportation problems and case of degeneracy, Assignment problems, Least time transportation problem.

**Network Analysis:** CPM/PERT, Network Representation, Techniques for drawing network, Numbering of events (Fulkersen Rule), PERT calculations - Forward path, back-ward path, Slack, probability, comparison with PERT, Critical path, Float, Project cost, Crashing the net work, updating (PERT and CPM).

**UNIT-III**

**Decision Theory:** Steps in decision theory approach, Decision Machinery environment, Decision machining under certainty and uncertainty, Decision machining under condition of risk, Decision trees, Minimum enchained criteria, Advantages and limitations of decision tree solutions, Post Optimality.

**UNIT-IV**

**Queuing Theory**: Introduction, Applications of queuing Theory, Waiting time and idle time costs, Single channel queuing theory and multi-channel queuing theory with Poisson arrivals and exponential services, Numerical on single channel and multi channel queuing theory.

**TEXT BOOKS:**

1. Operations Research by Prem Kumar Gupta and D. S. Heera, S. Chand Publications
2. Introduction to Operations Research, by F.S. Hillier and G.J. Lieberman, seventh edition, McGraw Hill publications

**REFERENCE BOOKS:**

1. Introduction to Mathematical Programming by Winston, W.L. (4th ed.), Duxbury Press.
2. Operations Research by P SankaraIyer, McGraw Hill publications.

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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| **Open Elective-III** | **B.Tech (8th Sem Mechatronics Engineering)** | | | | | | |
| **MTO-410A** | **Sensors and Actuators** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students knowledgeable about the fundamentals of Sensors and Actuators.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to attain the knowledge about displacement measurement sensors.** | | | | | | |
| **CO 2** | **Students will be able to explain the concepts of proximity, force and pressure measurement sensors.** | | | | | | |
| **CO 3** | **Students will be able to apply the concepts of velocity, flow and level measurement sensors** | | | | | | |
| **CO 4** | **Students will be able to understand the concepts of light sensors, micro sensors and actuators.** | | | | | | |

**UNIT-I**

**INTRODUCTION AND DISPLACEMENT MEASUREMENT:** Sensors - Basic requirements of a sensors- Classification of sensors- Static and Dynamic characteristics of sensors- Displacement Sensors- Linear and Rotary displacement sensors Potentiometer, Capacitive and Inductive type displacement sensor- position sensors- Optical encoder, Photoelectric sensor, Hall Effect Sensor.

**UNIT-II**

**MEASUREMENT OF PROXIMITY, FORCE AND PRESSURE:** Eddy current proximity sensor- Inductive Proximity sensor- Capacitive Proximity sensor - Pneumatic Proximity sensors- Proximity Switches- Contact and Noncontact type – Strain Gauge – Diaphragm Pressure Sensor- Capsule Pressure sensors- Bellows Pressure SensorBourdon tube pressure sensor- Piezoelectric Sensor- Tactile sensor.

**UNIT-III**

**MEASUREMENT OF VELOCITY, FLOW AND LEVEL:** Tacho generator – Pyroelectric sensors - Ultrasonic sensor – Resistive sensor- Pitot tube – Orifice plate - flow nozzle- Venturi tubes – Rotameter- Electromagnetic flow meter. Float level sensor- Pressure level sensor- Variable capacitance sensor.

**UNIT-IV**

**MEASUREMENT OF TEMPERATURE, MOTION AND LIGHT SENSORS:** Thermocouples- Thermistors, Thermodiodes, Thermo-transistors- Bimetallic Strip Resistance Temperature Detector- Infrared Thermography. Vibrometer and accelerometerseismic accelerometer. Photoresistors -Photodiodes - Phototranistors- Photocondutors.

**MICRO SENSORS AND ACTUATORS** Micro Sensors: Principles and examples, Force and pressure micro sensors, position and speed micro sensors, acceleration micro sensors, chemical sensors, biosensors, temperature micro sensors and flow micro sensors. Micro Actuators: Actuation principle, shape memory effects-one way, two way and pseudo elasticity. Types of micro actuators- Electrostatic, Magnetic, Fluidic, Inverse piezoeffect, other principles.

**TEXT BOOKS**

1. Sawhney.A.K, “Course in Mechanical Measurements and Instrumentation”, Dhanpat Rai and Sons, 1997.

2. Patranabis.D, “Sensors and Transducers”, Wheeler publisher, 1994.

3. Sergej Fatikow and Ulrich Rembold, Microsystem “Technology and Microbotics” First edition, Springer -Verlag NEwyork, Inc, 1997.

4. Gupta.I.C, “A Text book of Engineering Metrology”, Dhanpat Rai and Sons, 1996.

5. “ASTE Hand Book of Industries Metrology”, Prentice Hall of India, 1992.

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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| **Open Elective-III** | **B.Tech (8th Sem Mechatronics Engineering)** | | | | | | |
| **MTO-412A** | **Solar Energy** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students well versed in the fundamentals of Solar Energy.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to apply concepts of Solar Energy.** | | | | | | |
| **CO 2** | **Students will be able understand about concentrated solar power and system.** | | | | | | |
| **CO 3** | **Students will be able to explain solar thermal energy.** | | | | | | |
| **CO 4** | **Students will be able to apply concepts of solar cells.** | | | | | | |

**UNIT-I**

**INTRODUCTION:** Basic Heat Transfer Principles- Availability of Solar Energy- Nature of Solar Energy- Solar Energy & Environment- Sun as the source of radiation- Solar radiation- Measurement of solar radiation Irradiance- Solar constant- Insolation- Radiosity- Emissive power- Earth‟s equator- Meridian Longitude- Sun earth angles- Sunrise, sun set and day length- Solar time- Equation of time, Various Methods of using solar energy- Photo thermal, Photovoltaic, Photosynthesis, Present & Future Scope of Solar energy.

**UNIT-II**

**SOLAR CELLS:** Various generations- Semiconductor materials- Doping- Fermi level- PN junction and characteristics- Photovoltaic effect- Photovoltaic material- Parameters of solar cells- Effects of cell temperature on cell efficiency- Types of solar cells- Solar modules and arrays- Advantages and limitations of solar energy system- Solar cell power plant- Silicon, thin film and polymer processing- Silicon wafer based solar cells.

**UNIT-III**

**CONCENTRATED SOLAR POWER AND SYSTEM:** System components and their functions. Calculating output and dimensioning of solar cell systems. Analysis and computer simulation of a solar cell system. Concentrated sunlight and solar power (CSP). Properties of optical concentration systems. Solar cells in concentrated sunlight. Overview of the different components in a CSP system and their functions. Examples of CSP-systems globally.

**UNIT-IV**

**SOLAR THERMAL ENERGY:** Stationary collectors- FPC- CPC- ETC- Sun tracking concentrating collectors- PTC- PDR- HFC Fresnel collectors- Solar thermal power plants- Solar chimney power plant- Solar pond- Solar water heater- Solar cooker- Types- SODIS- Thermal energy storage- Solar cooling- Limitations of solar thermal energy.

**Solar Thermal Application:** Desalination, water heating, air heating, solar power plant.

**TEXTBOOKS:**

1. Soteris A. Kalogirou, „Solar Energy Engineering: Processes and Systems‟, Academic Press, London, 2009
2. Tiwari G.N, “Solar Energy – Fundamentals Design, Modelling and applications, Narosa Publishing House, New Delhi, 2002.

**REFERENCES:**

1. John W. Twidell & Anthony D.Weir, ‘Renewable Energy Resources,2005
2. John A. Duffie, William A. Beckman, Solar Energy: Thermal Processes, 4th Edition, john Wiley and Sons, 2013
3. Sukhatme S.P. Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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| **Program Elective-V** | **B.Tech (8th Sem Mechatronics Engineering)** | | | | | | |
| **MTP-402A** | **Non-Conventional Machining** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students knowledgeable about Non-Conventional Machining.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to understand about unconventional machining process.** | | | | | | |
| **CO 2** | **Students will be able to apply the concepts of Electrochemical machining and Electric discharge machining** | | | | | | |
| **CO 3** | **Students will be able to elaborate Laser beam machining.** | | | | | | |
| **CO 4** | **Students will be able to explain Laser beam machining.** | | | | | | |

**UNIT-I**

**Unconventional machining processes**: Classification, considerations in process selection. Ultrasonic machining: Elements of process, design of cutting tool, metal removal mechanism, effect of parameters, economic considerations, limitations and applications, surface finish.

**UNIT-II**

**Electrochemical machining:** Elements of process, process chemistry, metal removal mechanism, tool design, accuracy, surface finish and work material characteristics, economics advantages, limitations and applications

**Electric discharge machining:** Principle and mechanism of metal removal, generators, electrode feed control, electrode material, tool electrode design, EDM wire cutting, surface finish, accuracy and applications.

**UNIT-III**

**Electron beam machining:** Electron beam machining, laser beam machining, their princiles and metal removal mechanism, process parameters, advantages and limitations, applications.

**UNIT-IV**

**Laser beam machining:** Laser Beam Machining Process, principles, pumping processes, emission types-beam control. Applications Ultrasonic Machining Process-working principles-types of transducers concentrators- nodal point clamping-feed mechanism-metal removal rate- Process Parameters, Applications

**TEXT BOOKS:**

1. Modern machining processes By P.C. Pandey and M.S. Shan.

2. Machining Science By Ghosh and Mallik, Affiliated East West

3. Nontraditional Manufacturing processes By G.F. Benedict, Maicel Dekker.

**REFERENCE BOOKS:**

1. Advanced Methods of Machining -By J.A. Mc Geongh, Chapman and Hall.

2. Electrochemical Machining of Metals -By Rurnyantsev & Davydov, Mir Pub.

3. Rapid prototyping: Principles and applications in Manufacturing

4. A Text Book: of Production Engineering, P.C.Sharma

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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| **Program Elective-V** | **B.Tech (8th Sem Mechatronics Engineering)** | | | | | | |
| **MTP-404A** | **Welding Technology** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students conversant with Welding Technology.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to explain Gas and Arc welding processes.** | | | | | | |
| **CO 2** | **Students will be able to apply the knowledge of resistance welding process.** | | | | | | |
| **CO 3** | **Students will be able to apply the knowledge of solid state welding process.** | | | | | | |
| **CO 4** | **Students will be able to understand design of weld joint, weldability and testing of weldments.** | | | | | | |

**UNIT-I**

**Gas and Arc Welding Processes:**

Fundamental principles – Air Acetylene welding, Oxyacetylene welding, Carbon arc welding, Shielded metal arc welding, Submerged arc welding, TIG & MIG welding, Plasma arc welding and Electroslag welding processes - advantages, limitations and applications.

**UNIT-II**

**Resistance Welding Processes:**

Spot welding, Seam welding, Projection welding, Resistance Butt welding, Flash Butt welding, Percussion welding and High frequency resistance welding processes – advantages, limitations and applications.

**UNIT-III**

**Solid State Welding Processes:**

Cold welding, Diffusion bonding, Explosive welding, Ultrasonic welding, Friction welding, Forge welding, Roll welding and Hot pressure welding processes – advantages, limitations and applications.

**UNIT-IV**

**Design of Weld Joints, Weldability and Testing of Weldments**

Various weld joint designs – Welding defects – causes and remedies – Weldability of Aluminium, Copper, and Stainless steels. Destructive and non destructive testing of weldments.

**TEXT BOOKS:**

* + - 1. Parmer R.S., “Welding Engineering and Technology”, 1st  edition, Khanna Publishers, New

Delhi, 2008.

2. Parmer R.S., “Welding Processes and Technology”, Khanna Publishers, New Delhi, 1992.

3. Little R.L., “Welding and welding Technology”, Tata McGraw Hill Publishing Co., Ltd., New

Delhi, 34th reprint, 2008.

**REFERENCES:**

* + - 1. Schwartz M.M. “Metals Joining Manual”. McGraw Hill Books, 1979.
      2. Tylecote R.F. “The Solid Phase Welding of Metals”. Edward Arnold Publishers Ltd. London, 1968.
      3. AWS- Welding Hand Book. 8th Edition. Vol- 2. “Welding Process”
      4. Nadkarni S.V. “Modern Arc Welding Technology”, 1st edition, Oxford IBH Publishers, 2005.
      5. Christopher Davis. “Laser Welding- Practical Guide”. Jaico Publishing House, 1994.
      6. Davis A.C., “The Science and Practice of Welding”, Cambridge University Press, Cambridge,

1993

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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| **Program Elective-V** | **B.Tech (8th Sem Mechatronics Engineering)** | | | | | | |
| **MTP-406A** | **Industrial Ergonomics** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students acquainted with the concepts of Industrial Ergonomics.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to understand the concepts of work study and work methods design.** | | | | | | |
| **CO 2** | **Students will be able to apply the concepts of work measurement and work sampling.** | | | | | | |
| **CO 3** | **Students will be able to explain Human Performance and Human Factors Engineering.** | | | | | | |
| **CO 4** | **Students will be able to analyze design of work space & equipments and environment.** | | | | | | |

**UNIT-I**

**Introduction to Work Study**: Productivity, Scope of methods, motion and time study.

**Work Methods Design**: Operation Process Chart, Flow Process Chart, Flow Diagram, String Diagram, Man and machine chart, two handed process chart, Travel Chart, Micro motion and memo motion study.

**UNIT-II**

**Work Measurement:** Tools and Techniques

**Work Sampling:** Determining time standards from standard data and formulas, Pre-determined motion time standards, Work factor system, Methods time measurement, Analytical Estimation, Measuring work by physiological methods – heart rate measurement – measuring oxygen

consumption– establishing time standards by physiology methods.

**UNIT-III**

**Human Factors Engineering:** Introduction to ergonomics, Man/machine/environment systems concept, Human Anthropometry and its use in work place layout.

**Human Performance:** Information input and processing, factors affecting human performance, physical work load and energy expenditure, heat stress, manual lifting, Static and dynamic muscular load, human motor activity, metabolism, physical work load, repetitive and inspection work, measurement of physical work load, mental work load and its measurement, musculoskeleton disorder, work duration and work pauses, principles of motion economy.

**UNIT-IV**

**Design of Work Space & Equipment:** Work-space design for standing and seated workers, arrangement of components with in a physical space, Interpersonal aspect of work place design, Ergonomic Factors to be considered, design of displays and controls, design for maintainability

**Design of Environment**: Illumination and its effect, Climate - Heat Humidity – Body heat balance, effective temperature scales, zones of discomfort, effect of heat on body and work performance, Vibrations - Response of body to low frequency vibrations, vibrations and discomfort, effect on health of worker, high frequency vibrations, effect of high frequency vibrations, methods of reducing vibrations, Noise - Physiological effects of noise, annoyance of noise, speed interference, hearing loss, temporary and permanent threshold shift, effect of noise on performance, reduction of noise, personal noise protection, Standards and social aspects.

**Text Books:**

1. Introduction to Work Study, I.L.O., 3rd Revised Edn.

2. Motion and Time Study – Design and Measurement of Work, Barnes, Raeph.m., John

Wiley & sons, New York.

3. Human Factors in Engineering and Design, Macormick, E.J., Tata McGraw-Hill

4. A Guide to Ergonomics of Manufacturing, Martin Helander, TMH.

5. Human Factor Engineering, Sanders & McCormick, McGrawhill Publications.

6. Sound, Noise and Vibration Control, Lyle, F. Yerges, Van Nostrand.

**Reference Books:**

1. Improving Productivity and Effectiveness, Mundel, Marvin, E., Prentice Hall.

2. Human Factors Engineering & Design, Sounders, M.S. and McCornic, E.J., McGraw

Hill.

3. Motion and time study, Benjamin .W. Neibel,, Richard .D .Irwin Inc., Seventh Edition.

4. Work design Stephen Konz., Publishing Horizon Inc., Second Edition.

5. Introduction to Ergonomics, Bridger R.S.,McGraw Hill.

6. Applied Ergonomics, Hand Book: Brien Shakel (Edited) Butterworth Scientific, London.

7. Work Study and Ergonomics, Shan, H.S, DhanpatRai& Sons.

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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| **Program Elective-VI** | **B.Tech (8th Sem Mechatronics Engineering)** | | | | | | |
| **MTP-408A** | **Artificial Intelligence & Expert Systems** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students knowledgeable about Artificial Intelligence & Expert Systems.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to understand the fundamentals of Artificial intelligence.** | | | | | | |
| **CO 2** | **Students will be able to analyze Handling uncertainty & Probabilistic reasoning.** | | | | | | |
| **CO 3** | **Students will be able to elaborate Expert System & Planning.** | | | | | | |
| **CO 4** | **Students will be able to understand the fundamentals of search techniques.** | | | | | | |

**UNIT-I**

**Overview of AI:** What is AI? The importance of AI, Early works in AI, AI and Related fields. Knowledge: Importance of Knowledge, knowledge-based system representation, organization, manipulation, acquisition.

**UNIT-II**

**Search Techniques:** Problem Solving, State space search, Blind search: Depth first search, Breadth first search, informed search: Heuristic search, Hill climbing search, Best first search, A\*, AO\*, Constraint satisfaction. Game Playing: Minimax search, Alpha – beta pruning.

**UNIT-III**

**Handling uncertainty & Probabilistic reasoning:** Bayes Net, Dempster Shafer Theory, Use of certainty Factors, Fuzzy Logic, Non monotonic reasoning, Dependency directed backtracking, Truth maintenance systems, Learning : Concept of learning, Learning automation, The Genetic algorithm, Learning by induction, Neural Networks: Hopfield Networks, Perceptrons- Learning algorithm, Back propagation Network, Boltzman Machine, Recurrent Networks.

**UNIT-IV**

**Planning:** Components of Planning System, Plan Generation Algorithms: Forward state propagation, Backward state propagation, Nonlinear planning using constraint posting, Natural Language Processing: Syntactic analysis, Top down and bottom up parsing, Augmented Transition Networks, Semantic analysis, case grammars.

**Expert System:** Need and Justification for expert systems- cognitive problems, Expert System Architectures( Rule based systems, Non production system, knowledge acquisition, Case studies: MYCIN ,

**TEXT BOOKS:**

1. Artificial Intelligence By Elaine Rich and Kevin Knight , Tata McGraw Hill.

2. Introduction to AI and Expert Systems By Dan W.Patterson, PHI.

**REFERENCE BOOKS:**

1. Principles of Artificial Intelligence By Nils J.Nilsson, Narosa Pub. house.

2. Foundation Artificial Intelligence & Expert Systems by VS Janakiraman K, Sarukesi P

Gopalakrishnan Macmillan series in computer science

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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| **Program Elective-VI** | **B.Tech (8th Sem Mechatronics Engineering)** | | | | | | |
| **MTP-410A** | **Micro Electro Mechanical Systems** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students well versed in Micro Electro Mechanical Systems.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to apply the concepts of micro systems.** | | | | | | |
| **CO 2** | **Students will be able to explain fabrication process.** | | | | | | |
| **CO 3** | **Students will be able to analyze micro system manufacturing.** | | | | | | |
| **CO 4** | **Students will be able to apply the concepts of micro sensors and actuators.** | | | | | | |

**UNIT-I**

**INTRODUCTION TO MICROSYSTEMS**

Overview of micro-electronics manufacture and Microsystems technology. Definition - MEMS materials. Laws of scaling. The multi disciplinary nature of MEMS. Survey of materials central to micro engineering. Applications of MEMS in various industries.

**UNIT-II**

**MICRO SENSORS AND ACTUATORS**

Working principle of Microsystems, micro actuation techniques, micro-sensors, Micro-actuators, micro-pump, micro-motors, micro–valves, micro-grippers, micro-accelerometers.

**UNIT-III**

**FABRICATION PROCESS**

Substrates, single crystal silicon wafer formation, Photolithography, Ion implantation, Diffusion, Oxidation, Physical vapor deposition, Deposition epitaxy, etching process.

**UNIT-IV**

**MICRO SYSTEM MANUFACTURING**

Bulk Micro manufacturing - surface micro machining – LIGA – SLIGA - Micro system packaging materials - die level - device level - system level - packaging techniques – die preparation – surface bonding - wire bonding - sealing.

**MICROSYSTEMS DESIGN AND PACKAGING**

Design considerations, Mechanical Design, Process design, Realization of MEMS components using intellisuite. Micro system packaging, Packing Technologies, Assembly of Microsystems, Reliability in MEMS.

**TEXT BOOKS**

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| --- |
| “Foundation of MEMS” by Chang Liu. Pearson Education. |

1. Mohamed Gad – el – Hak, “MEMS Handbook”, CRC Press, 2002.

2. Rai - Choudhury P. “MEMS and MOEMS Technology and Applications”, PHI Learning Private Limited, 2009.

3.  Sabrie Solomon, “Sensors Handbook,” Mc Graw Hill, 1998.

4.  Marc F Madou, “Fundamentals of Micro Fabrication”, CRC Press, 2nd Edition, 2002.

5. MEMS and Microsystems Design and Manufacture” by Tai-Ran Hsu. Tata McGraw Hill Publishing Company Ltd.

**REFERENCES**

1. Francis E.H. Tay and Choong .W.O, “Micro fluidics and Bio mems application”, IEEE Press New York, 1997.

2. Trimmer William S., Ed., “Micromechanics and MEMS”, IEEE Press New York, 1997.

3. Maluf, Nadim, “An introduction to Micro electro mechanical Systems Engineering”, AR Tech house, Boston 2000.

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Program Elective-VI** | **B.Tech (8th Sem Mechatronics Engineering)** | | | | | | |
| **MTP-412A** | **Quality and Reliability Engineering** | | | | | | |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3h** |
| **Purpose** | **To make students knowledgeable in Quality and Reliability Engineering .** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Students will be able to explain Quality Assurance.** | | | | | | |
| **CO 2** | **Students will be able to apply Statistical process control and control charts for variables.** | | | | | | |
| **CO 3** | **Students will be able to understand control charts for attributes and sample inspection.** | | | | | | |
| **CO 4** | **Students will be able to analyze system reliability and improvement.** | | | | | | |

**UNIT-I**

**Introduction**- Definition of Quality, Quality function, Dimensions of Quality, Brief history of quality methodology, Statistical methods for quality improvement, Quality costs, Introduction to Quality function deployment.

**Quality Assurance (QA)** - Introduction, Definition, Management principles in QA, Forms of QA, QA in different stages. Quality planning, QA program, QA aspect, Quality in material management, vendor selection & development.

**UNIT-II**

**Statistical Process Control** - Introduction to statistical process control, Concept of variation, Assignable & Chance causes, Attributes & variables, Frequency distribution curve & its types. Normal Distribution curve, Problems on FD curve & ND curve, Application of SPC.

**Control Charts for Variables**- Definition, Formulae & its problems. Control chart patterns, Process capability. Problems on x & R chart and Process capability.

**UNIT-III**

**Control Charts for Attributes**- Definition, Formulae & its problems. Problems on p, c charts. Choice between variables and attributes control charts. Guidelines for implementing control charts.

**Sampling Inspection** - Sampling: Definition, types of sampling, importance, benefits and limitations of sampling, Operating Characteristic Curve, Average Outgoing Quality Curve, Errors in Making Inferences from Control Charts (Type I and II errors).

**UNIT-IV**

**Reliability Concepts -** Introduction of Reliability concepts, Failure data analysis and examples, Failure rate, Failure density, Probability of failure, Mortality rate, Mean time to failure, Reliability in terms of Hazard rate and Failure Density, examples, Useful life and wear out phase of a system,

**System Reliability and Improvement**: Reliability of series and parallel connected systems and examples, Logic diagrams, Improvement of system reliability, Element Redundancy, Unit redundancy, Standby redundancy

##### TEXT BOOKS:

1.Mahajan, “Quality Control and Reliability”, Dhanpat Rai & Sons

2. Srinath L S, “Reliability Engineering”, East west press.

3. Sharma S C, Inspection Quality Control and Reliability, Khanna Publishers

**REFERENCE BOOKS:**

1. Grant E L, Statistical Quality Control“, McGraw-Hill.

**Note:** *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit*