SVKM's Narsee Monjee Institute of Management Studies
Mukesh Patel School of Technology Management and Engineering

Program: B. Tech. (Mechatronics Engineering)				**Semester:** III	
Course/Module: Mathematics -III				**Module Code:** BTMA03007	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks- 100 in Question Paper)**
3	0	1	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Mathematics-I (BTMA01001) & Mathematics-II (BTMA02008)

Objectives:

1. To provide an understanding of Laplace transform and its applications, Fourier series, Fourier Transform, Z-transform
2. To provide students with mathematics fundamentals necessary to formulate, solve and analyses complex engineering problems

Outcomes:

After completion of the course, students would be able to:

1. Solve problems using Laplace transform, Fourier series, Fourier Transform, Z - transform.
2. Analyze the concept of Laplace transform, Fourier series, Fourier Transform, Z - transform.
3. Apply the techniques of Laplace transform, Fourier series, Fourier Transform and Z - transform to engineering problems.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1	**Laplace transformation:** Definition of Laplace transform, Laplace transform of 1, e^{at}, $\sin at$, $\cos at$, $\sinh at$, $\cosh at$, t^n, Properties of Laplace transform: Linearity property, First and second shifting theorems of Laplace transform, Change of scale property, $L\{t^n f(t)\}$, $L\left\{\frac{f(t)}{t}\right\}$, $L\{f^n(t)\}$, $L\left\{\int_0^t f(u)\,du\right\}$, Evaluation of Inverse Laplace transform by partial fraction, Convolution theorem, Laplace transforms of Periodic functions, Unit step functions, Dirac delta functions. Applications: to solve initial and boundary value problems involving ordinary differential equations.	13
2	**Fourier series:** Orthogonality and Orthonormality, Periodic function, Trigonometric Series, Dirichlet's conditions, Euler's formulae (Derivative of Fourier coefficients a_0, a_n, b_n is not expected), Fourier Series of Functions for the interval $[\alpha, \alpha+2\pi]$ and $[\alpha, \alpha+2c]$, Functions having points of discontinuity, Even	10

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	and odd functions, half range sine and cosine expansions, Parseval's identities. Complex form of Fourier series, Fourier integral theorem, Fourier sine and cosine integral.	
3	**Fourier Transform:** Fourier Transform, Fourier Sine Transform, Fourier Cosine Transform, Properties of Fourier Transform (Linearity property, Change of scale property, Shifting property), Inverse Fourier Transform, Inverse Fourier Sine Transform, Inverse Fourier Cosine Transform, Finite Fourier Transform. Application: Fourier transform to solve differential equations.	09
4	***Z*-transforms:** Introduction, Sequences, Representation of sequences, Basic operators on Sequences, *Z*-transforms, Properties of *Z*-Transforms, Change of scale, Shifting Properties, Inverse *Z*-transform, Solution of Difference equations, Multiplication by *K,* Division by *K,* Initial value, Final value, Partial sum, Convolution, Convolution Property of Casual Sequence, Transform of important sequences, Inverse of Z-transform by division, binomial expansion and partial fraction, Inverse by residue Method, Solution of Difference equation.	13
	Total	**45**

Text Books:

1. B. V. Ramana (2017), "Higher Engineering Mathematics", *McGraw Hill Education*, *1st Edition.*

Reference Books:

1. G. B. Thomas (2014), "Calculus", *Pearson, 13th Edition.*
2. Erwin Kreyszig (2017), "Advanced Engineering Mathematics", *Wiley India, 10th Edition.*
3. B. S. Grewal (2017), Higher Engineering Mathematics, *Khanna Publishers, 44th Edition.*

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	Marks
Test Marks	20
Term Work Marks	30
Total Marks :	**50**

Details of Term work:

Term work should consists of the following:

- Tutorial Test/Presentation/viva/quiz

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SVKM's Narsee Monjee Institute of Management Studies
Mukesh Patel School of Technology Management and Engineering

Program: B. Tech. (Mechatronics Engineering)				**Semester :** III	
Course/ Module: Presentation and Communication Techniques				**Module Code :** BTMA03008	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks – 50)**	**Term End Examinations (TEE) (Marks – -- in Question Paper)**
2	0	0	2	Marks Scaled to 50	---

Pre-requisite: Nil

Objectives:

1. To impart an understanding of basic tenets of business communication that helps students to effectively engage in organizational communication.
2. To develop in students an understanding of interpersonal communication challenges and the ability to effectively overcome these challenges in an organizational context.
3. To develop leadership, team building and decision making skills which could be later applied in a professional set up.
4. To impart technical writing skills towards designing and structuring persuasive technical communication.
5. To build and strengthen presentation skills towards making impressive and persuasive presentations.
6. To train the students for participating in group discussions, building Resume and facing personal interviews.

Outcomes:

After completion of the course, students would be able to:

1. Understand and apply the postulates of technical writing in a formal set up
2. Apply fundamentals of business correspondence to create well-structured Resumes, application letters, Minutes of Meetings and similar business related documents
3. Understand and analyse group dynamics and apply leadership skills for effective team building in professional set ups.
4. Analyze the context and select appropriate communication techniques for effective interpersonal communication in professional context.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1	**Understanding the foundations of Business Communication:** Professional Communication in a Digital, Social, Mobile World	05
2	**Collaboration, Interpersonal Communication and Business Etiquette:** Communicating effectively, collaborating, conducting productive meetings, using meeting technologies, improving listening skills and non-verbal communication, business etiquettes.	05
3	**Development of Interpersonal and Group Communication Skills** Theatre techniques: Use of drama (in workshop format) to promote meaningful,	

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	active and reflective thinking processes as well as enhancing communication skills development. **Group Communication** • Forms of Group Communication; Use of body language in Group communication • Group Discussion etiquette: Introducing oneself and others; Expressing Opinions and Ideas; expressing disagreement etc. • Group Discussion Strategies: Speaking, taking turns, Creating a Cordial and cooperative atmosphere etc.	04
4	**Building Problem-solving teams** • Orientation to Personality Values – Importance of Values • Understanding of Teams- Types of Teams, stages of Team development; Team building leadership skills and leaderless scenarios • Decision Making-Group and Individual Decision Making Techniques • Stress Management-Sources of Stress; consequences; Managing Stress	04
5	**Employment Communication** • Personal Interviews-Objectives, Types, Stages of Interview • Interview Preparation-types of Interview Questions ; Interview Follow ups • Resume- Types and Format**;** Cover letters • Mock Interviews (simulation)	04
6	**Organizational networks and communication Structures** • Process and Functions of Communication ;Formal Networks in Organizational Communication • Informal networks of organizational communications ;choice of communication channels	02
7	**Meetings** • Meetings- Purposes ,Importance and Meeting Procedures including Chairperson's and participants' roles • Meeting Documentation (Minutes of resolution; Minutes of Narration; Meeting Notice and Agenda)	02
8	**Technical Report Writing** • Importance , objectives and Characteristic of Reports ; Types of Reports • Report formats and Structure -Memo Reports; Letter Reports; Office Orders and Manuscript Reports	02
9	**Presentation Skills** • Planning and structuring Presentations; Visual Aids in Presentations	02

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	• Applications of MS Power Point • Audience analyses; Nuances of Delivery; Modes of delivery; Controlling Nervousness and stage fright	
	Total	**30**

Text Books:

1. Bovee, C., Thill, J., & Roshan Lal Raina (2013), "*Business Communication Today", Pearson. 14th edition.*
2. Meenakshi Raman and Sangeeta Sharma (2015), "Technical Communication", *Oxford University Press, 3rd Edition.*

Reference Books:

1. Fred Luthans (2013), 'Organizational Behavior', *McGraw Hill, 12th Edition.*

Any other information:

1. Links to websites:

- https://www.mindtools.com/
- https://www.pearsonmylabandmastering.com/northamerica/mybcommlab/

2. Pedagogy:

1. Classroom teaching
2. classroom exercises and discussion
3. case studies
4. written assignments
5. presentations and role play

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

Term work should consists of the following:

1. Group/Individual presentations
2. Report writing-Memo Reports and letter reports
3. Drafting meeting Agenda and Minutes of Meeting
4. Resume and Cover letter writing
5. Group Discussion
6. Mock Interviews

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SVKM's Narsee Monjee Institute of Management Studies
Mukesh Patel School of Technology Management and Engineering

Program: B. Tech. (Mechatronics Engineering)				**Semester :** III	
Course/ Module: Digital Electronics				**Module Code :** BTMA03009	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks- 100 in Question Paper)**
3	2	0	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Nil

Objectives:

1. To provide knowledge of digital logic & digital system as well as their applications in technical field.
2. To provide knowledge of designing the digital logic circuit using basic building blocks and necessary techniques which is required in computer hardware design.

Outcomes:

After completion of the course, students would be able to:

1. Apply the knowledge of fundamental number systems and the various codes.
2. Design Combinational Logic Circuits.
3. Implement Sequential Logic Circuits which can be applied for real time applications for complex digital circuits and systems.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1	**Introduction to Digital Systems & Binary Codes:** Comparison of Analog and Digital Systems, Number Systems: binary, octal, hexadecimal, BCD and others. Conversion from one system to another, Binary Arithmetic including 1's and Two Complement Arithmetic, Importance of Binary and Hexadecimal Numbers. Weighted, reflective, sequential, gray, error detecting codes, even parity, Hamming codes, alphanumeric, Morse, teletypewriter ASCII, EBCDIC codes, converting binary to gray and gray to binary and XS3.	06
2	**Logic Gates and Boolean Algebra:** AND, OR, NOT, XOR, XNOR, operation NAND, NOR use of universal gates for performing different operations. Laws Boolean algebra, DeMorgan's theorems. Relating truth table to a Boolean expression. Multi-level circuits.	04
3	**Combinational Logic Circuits:** Canonical Logic Form, minterm, maxterm SOP and POS implementation. Implementing a logic function using universal gates. K-maps and their use in simplifying Boolean expressions, Variable entered maps for five and six variables functions.	16

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	Design of Code converter circuits-Binary to Gray, BCD to 7 segments, priority encoder, Binary comparator, binary arithmetic circuits – adders, subtractors (half and full), BCD adder, subtractor, ALU, Parity generator. Multiplexers (ULM), De-multiplexers, Decoders, Encoders, Tree structures. Hazards in combinational circuits.	
4	**Sequential Logic Circuits:** Comparison of combinational and sequential circuits, flip-flops, SR, T, D, JK, master slave JK, converting one flip-flop to another, use of debounce switch. Synchronous and Asynchronous Counters, modulus of a counter, up / down counter, Counter designing by drawing state transition diagram and state transition table using all kinds of Flip –Flops. Ring counter, Johnson counter, twisted ring counter, Finite and Mixed state Machines- Mealy and Moore Design, Logic state diagram analysis.	12
5	**Registers & Memories:** Serial input -serial output; serial input-parallel output; Parallel In -Parallel Out, Serial In -Serial Out, Bi Directional Shift Registers, Universal Shift Registers. RAM, ROM, basic bipolar cell, CMOS, dynamic RAM cell. Magnetic core NVRAM, bubble memory, CCD, PAL, PLA, FPGA.	05
	Introduction to VHDL	02
	Total	**45**

Text Books:

1. Morris Mano (2008), "Digital Design", *PHI*, *4th edition.*
2. Malvino & Brown (2008), "Digital Computer Electronics", *Tata McGraw Hill*, *Reprint 3rd Edition.*

Reference Books:

1. R.P Jain (2007), "Digital Electronics and Microprocessors", *Tata McGraw-Hill, 25th reprint*
2. Roth and John (2011), "Principles of Digital Systems Design", *Cengage Learning, Sixth Indian Reprint*.

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

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Details of Term work:

Term work should consists of the following:

1. Minimum two assignments.
2. Minimum ten laboratory Experiments covering the whole syllabus, duly recorded and graded.
3. Quiz/ Viva/ Presentation.

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SVKM's Narsee Monjee Institute of Management Studies
Mukesh Patel School of Technology Management and Engineering

Program: B. Tech. (Mechatronics Engineering)				**Semester:** III	
Course/ Module: Engineering Mechanics				**Module Code:** BTMA03010	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks- 100 in Question Paper)**
3	2	0	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Physics (BTMA01003)

Objectives:

1. The objective of this Course is to provide an introductory treatment of Engineering Mechanics to all the students of engineering, with a view to prepare a good foundation for taking up advanced courses in the area in the subsequent semesters
2. A working knowledge of statics with emphasis on force equilibrium and free body diagrams provides an understanding of the kinds of stress and deformation and how to determine them in a wide range of simple, practical structural problems, and an understanding of the mechanical behaviour of materials under various load conditions.

Outcomes:

After completion of the course, students would be able to:

1. Determine resultant forces and equilibrium of various force systems.
2. Determine centroid and moment of inertia of plane areas.
3. Determine the displacement, velocity, acceleration & their components for a moving particle and rigid body.
4. Determine forces produced due to motion of particles and rigid body.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	**System of Forces:** Resultant of coplanar concurrent and non-concurrent forces, Resultant of concurrent and non-concurrent forces in space **Equilibrium:** Equilibrium of system of concurrent and non-concurrent forces in plane and space, Free body diagrams.	08
2.	**Application of Coplanar Forces and Equilibrium:** Trusses: Evaluation of member forces using method of sections and method of joints. **Beams:** Evaluation of reactions using equilibrium and principle of virtual work Simple frames: Evaluation of reactions using equilibrium	08
3.	**Friction:**	05

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	Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; wedge friction, screw jack	
4.	**Centroid and Centre of Gravity:** Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia-Definition, Moment of inertia of plane sections from first principles, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Sphere	06
5.	**Kinematics of Particles:** Rectilinear motion; Plane curvilinear motion (rectangular, path and polar coordinates), velocity-time graph and their usage, relative motion; Newton's 2nd law (rectangular, path, and polar coordinates). Kinematics of Rigid Bodies: Translation, pure rotation and plane motion of rigid bodies, ICR, link mechanisms	10
6.	**Kinetics of Particles and Rigid Bodies:** Newton's Law of motion, D'Alembert's principle, equation of dynamic equilibrium, Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body in translation, rotation and plane motion.	08
	Total	**45**

Text Books:

1. Irving H. Shames (2008), "Engineering Mechanics", *Prentice Hall, 4th Edition.*
2. R. C. Hibbler (2017), "Engineering Mechanics: Principles of Statics and Dynamics", *Pearson Press.*

Reference Books:

1. F. P. Beer and E. R. Johnston (2017), "Vector Mechanics for Engineers", Vol I & II, *Tata McGraw Hill, 9th Edition.*
2. Shanes and Rao (2006), "Engineering Mechanics", *Pearson Education.*
3. Hibler and Gupta (2010), "Engineering Mechanics (Statics, Dynamics)", *Pearson Education*
4. Tayal A.K. (2010), "Engineering Mechanics", *Umesh Publications*

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

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Details of Term work:

Term work should consist of the following:

1. Minimum ten Experiments covering the whole syllabus, duly recorded and graded.
2. Minimum five assignments covering the syllabus

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SVKM's Narsee Monjee Institute of Management Studies
Mukesh Patel School of Technology Management and Engineering

Program: B. Tech. (Mechatronics Engineering)				**Semester:** III	
Course/ Module: Manufacturing Processes				**Module Code:** BTMA03011	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks- 100 in Question Paper)**
3	0	0	3	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Workshop Practice (BTAB02006)

Objectives:

1. To introduce different manufacturing processes like casting, forging, machining, rolling etc.
2. To impart knowledge of various process equipment used in manufacturing processes.

Outcomes:

After completion of the course, students would be able to:

1. Understand and differentiate the different types of metal casting and forming process.
2. Explain the different types of equipment used in casting, and metal forming process.
3. Understand the operations of lathe, milling and drilling machines
4. Know the abrasive machining processes

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1	**Metal Casting:** **Pattern Making**: Types of patterns, allowances, color coding; Foundry practices **Moulding sands**: types, properties, preparation and testing of sand. Core boxes, core making, types of cores and their manufacturing; Gating system – runner and risers; **Moulding processes**: shell moulding, CO_2 moulding, investment casting, die casting, centrifugal casting and continuous casting; Study of various defects in castings.	09
2	**Forming processes:** Cold and hot working **Rolling:** Principle and mechanism, types of rolling and their applications, defects in rolling. **Forging:** Classification of forging processes, basic categories and methods of forging, heat treatment of forged parts. **Extrusion**: Hot and cold Extrusion, Equipment, Estimation of extrusion force, defects in extruded parts; wire and tube. **Drawing**: Metal Stamping and Forming, blanking, piercing, bending, deep drawing, roll forming, shear forming and flow Forming. **Press tools:** Different type of presses and their working, strip layout, Progressive die, Compound and combination dies.	12

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3	**Abrasive Machining Processes:** Mechanics of grinding, types and operations of grinding machines, Centerless grinding, Grinding wheel specifications and its selection, Truing and dressing of wheels, super finishing processes such as lapping and honing. Abrasive jet machining (AJM) and Abrasive water jet machining (AWJM).	06
4	**Machining Operations:** **Lathe:** Construction and working and operations performed on lathe, attachments and accessories, types of cutting tools, cutting parameters such as spindle speed, feed and depth of cut, Capstan and Turret lather, automatic lathes and their construction. **Milling Machines:** Types of milling machines, tools and their geometry, various operations on milling machine, different attachments (including dividing heads) and work holding devices. **Drilling Machines:** Types of machines, drilling operations such as drilling, boring, reaming, spot facing, counter boring and sinking, tapping, drill speed and feeds. **Boring and Broaching Machine:** Classification – horizontal and vertical boring machine, types of broaching machines, advantages, limitations and applications of broaching.	18
	Total	**45**

Text Books:

1. P. N. Rao (2008), "Manufacturing Technology-Vol I", *Tata McGraw Hill*.
2. S. Kalpakjian and S. R. Schmid (2002), "Manufacturing Engineering and Technology", *4th Edition, Pearson*.

Reference Books:

1. G. K. Lal (2010), "Fundamentals of Manufacturing Processes", *Alfa Science International*.
2. W. A. J. Chapman (2011), "Work Shop Technology- Vol I, II, III", *ELBS Publishers*.
3. Kou Sindo (2003), "Welding Metallurgy", *Wiley Inter science.*

Any other information:

Links to website:

1. http://nptel.ac.in/courses/112107145/
2. http://nptel.ac.in/courses/112107144/

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

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Term work should consists of the following:

1. Minimum four assignments based on the above syllabus.
2. Visit to any nearby foundry/ fabrication unit.
3. Viva voce, quizzes, Presentations based on syllabus.

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SVKM's Narsee Monjee Institute of Management Studies
Mukesh Patel School of Technology Management and Engineering

Program: B. Tech. (Mechatronics Engineering)				**Semester:** III	
Course/ Module: Analog Devices and Circuits				**Module Code:** BTMA03012	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks- 100 in Question Paper)**
3	2	0	4	Marks Scaled to 50	Marks Scaled to 50
Pre-requisite: Basic Electrical Engineering (BTMA01002), Physics (BTMA01003)					

Objectives:

1. To understand the construction, working principle, characteristics and simple applications of basic electronic devices.
2. To know the ac small signal models of BJT and JFET.
3. To provide knowledge of the circuit building block of Op-Amp, its dc and ac equivalent circuit and its applications.
4. To understand and provide knowledge of various Analog Integrated circuits such as IC 741, 555 timer, IC 337 and IC 723 voltage regulator.
5. To understand the different types of filters and design them for the given specifications.

Outcomes:

After completion of the course, students would be able to:

1. Identify various semi-conductor devices and analyze small and large signal models.
2. Know various configurations and specifications of ideal and practical Op-Amp.
3. Analyze the working of power controller, PLL, VCO ICs and their applications.
4. Design various filter circuits.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1	**Semiconductor Diodes and Applications:** Construction, Working and Characteristics of PN junction diode. Diode equation and temperature effects. Types of diodes – Zener, LED, Schottky, Photodiode. **Diode Applications:** Half wave, Full Wave (Center-tap and Bridge) rectifier circuits and working. Capacitive Filter – theory and limitations. **Clipper and Clamper Circuits:** Basic Series and Shunt Clipper Circuits, Clamper Circuits.	08
2	**Bipolar Junction Transistor:** Construction, working, and input-output characteristics of ***npn*** transistor. Modes of operation – cutoff, active, and saturation. Transistor configurations – CB, CE and CC.	06

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	BJT Biasing: Working, limitations and advantages of Fixed Bias, Collector Feedback, Voltage Divider Bias. **BJT Applications:** BJT as an AC amplifier. BJT as a switch.	
3	**Field Effect Transistor:** Construction and working of p-channel JFET. Construction, Working and input – output characteristics of n-channel JFET. **JFET Biasing:** Working, limitations and advantages of Fixed Bias, Self Bias, Voltage Divider Bias. **JFET Applications:** JFET as an AC amplifier	04
4	**BJT and FET Small Signal Amplifier:** Working of DC – RC Transformer BJT amplifier (CB, CE, CC). Working of DC – RC JFET amplifier (CS, CD). Positive and Negative Feedback circuits – advantages and limitations. **Feedback Applications:** Negative Feedback –Current and Power Amplifiers (Class A, B and AB). Positive Feedback – Barkhausen Criteria.	09
5	**Operational Amplifiers:** Parameters, working (open loop) and characteristics of IC 741C. **Applications of Closed loop with negative feedback (Ideal):** Inverting, Non-inverting, Buffer, Adder, Scalar, Subtractor, Differentiator, Integrator, V to I, I to V converters, Instrumentation Amplifiers with 3 Op-amp	05
6	**Non-linear Op-Amps:** Comparator, Schmitt Trigger, Precision HW Rectifier, Peak Detector, Sample and Hold Circuit, Basic Log Amplifier.	04
7	**Oscillators and Timer Circuits:** Working of RC and Wien Bridge Oscillator using op-amp. IC555 Timer Circuits: Working of Astable and Monostable multivibrator circuits. **VCO Circuits:** IC 566 block diagram and working. **PLL circuits:** Working of IC 4046 CMOS PLL. **Series Regulator and 3 Terminal Regulators:** IC 337 and IC 723.	05
8	**Filter Circuits:** First Order Filters **-** Low Pass, High Pass, Band Pass and Band Reject filters. Notch Filter. All Pass filter.	04
	Total	**45**

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Text Books:

1. Donald A. Neamen (2006), Electronic Circuit Analysis and Design, *McGraw Hill International, 3rd Edition.*
2. David A. Bell (2008), Electronic Devices & Circuits, *Prentice Hall India Pvt. Ltd, 5th Edition.*
3. R. A. Gayakwad (2009), Op-Amps and Linear Integrated Circuits, *Prentice Hall of India Pvt. Ltd, 4th edition.*
4. Sergio Franco(2002), Design with operational amplifiers and analog circuits, *McGraw Hill, 3rd edition.*

Reference Books:

1. Adel S. Sedra, Kenneth Carlers Smith (2004), Microelectronic Circuits, Volume 1, *Oxford University Press.*
2. Robert Boylestad & Louis Nashelsky (2007), Electronic Devices & Circuit Theory, *Pearson Education India, 9th Edition.*
3. Jacob Millman, Christos Halkias, Chetan Parikh (2009), Integrated Electronics, *McGraw hill Publication, 2nd Edition.*
4. Robert Coughlin and F. Driscoll(2009), Operational Amplifiers and Linear Integrated Circuits, *Prentice Hall of India Pvt. Ltd, 6th edition.*

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

Term work should consists of the following:

1. Minimum two assignments.
2. Minimum ten laboratory Experiments covering the whole syllabus, duly recorded and graded.
3. Quiz/ Viva/ Presentation.

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SVKM's Narsee Monjee Institute of Management Studies
Mukesh Patel School of Technology Management and Engineering

Program: B. Tech. (Mechatronics Engineering)				**Semester :** IV	
Course/ Module : Mathematics - IV				**Module Code :** BTMA04008	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks- 100 in Question Paper)**
3	0	1	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Mathematics-I (BTMA01001) & Mathematics-II (BTMA02008)

Objectives:

1. To develop knowledge of standard statistical and Numerical techniques and application to problems in day to day life involving areas of uncertainty such as inventory, maintenance, quality, resource availability, demand, computation and decision making .

Outcomes:

After completion of the course, students would be able to:

1. Solve algebraic, transcendental and differential equations using numerical methods; Estimate and analyze errors in the numerical solution.
2. Implement appropriate techniques of differentiation, integration, interpolation and curve fitting to discrete numerical data.
3. Identify suitable probability distribution and testing techniques for solving problems.
4. Apply the knowledge of random variables, probability distribution, statistical methods and Numerical Techniques to solve real life problems.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	**Errors in Numerical Computation:** Types of Errors, Analysis and Estimation of Errors, General Error Formula, Errors in Taylor's Series for Approximation of Functions.	03
2.	**Roots of Equations:** Bisection method, False position method, Newton-Raphson method, Secant method.	05
3.	**Interpolation and Curve fitting:** Forward, Backward and Central Differences, differences of a polynomial, Newton's Interpolation formulae, Stirling's Central Difference interpolation formula, Lagrange's formula for unequal intervals. Curve fitting: Least square method for straight line and parabola, Method of group averages.	11

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4.	**Numerical Integration:** Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule.	04
5.	**Solution to Ordinary differential equations:** Taylor series method, Euler's method, Runge-Kutta methods.	04
6.	**Probability Distribution:** Introduction to random variable, Discrete and continuous random variables, Probability density function, Cumulative distribution function, Expectation, Mean and Variance, Discrete Probability distributions-Binomial, Poisson, Continuous probability distributions-Exponential, Normal.	09
7.	**Testing of hypothesis:** Null and Alternate hypothesis, Test Statistic, Type I and Type II errors, One-tailed and two-tailed test, Critical value, Large sample statistical test for population mean, Large sample statistical test for proportion, t-test for small samples, Chi-square test for Goodness of fit, Kolmogorov-Smirnov test for goodness of fit.	09
	Total	**45**

Text Books:

1. Steven C. Chapra, Raymond P. Canale (2010), "Numerical Methods for Engineers", *Tata Mc-Graw Hill, 6th Edition.*
2. S.P. Gupta(2007), "Statistical Methods", *Sultan Chand & Sons Publication, 35th Edition.*

Reference Books:

1. S.S. Sastry (2013), "Introductory methods of numerical analysis ", *PHI Learning Private Limited, 5th Edition.*
2. T. Veerarajan(2017), "Probability, Statistics and Random Processes", *McGraw-Hill Education, 3rd Edition.*
3. Irwin Miller, John E. Freund and R.A. Johnson(2000), "Probability & Statistics for Engineer", *PHI, 7th Edition.*

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Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	Marks
Test Marks	20
Term Work Marks	30
Total Marks :	50

Details of Term work:

Term work should consists of the following:

1. Tutorial Test/Presentation/viva/quiz

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SVKM's Narsee Monjee Institute of Management Studies
Mukesh Patel School of Technology Management and Engineering

Program: B. Tech. (Mechatronics Engineering)				**Semester :** IV	
Course/ Module: Principles of Economics and Management				**Module Code:** BTMA04009	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks – 50)**	**Term End Examinations (TEE) (Marks- 100 in Question Paper)**
3	0	0	3	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Nil

Objectives:

This course provides basic orientation towards economic (micro and macroeconomic) principles and help them understand the functions of management

1. To combine elements of basic micro and macroeconomics
2. To understand issues dealing with small-scale economic phenomena and concepts such as prices and output of firms, industries and resource owners
3. To examine market impact of technological change
4. To understand broader aspects of the economy and its environment

Outcomes:

After completion of the course, students would be able to:

1. Analyze and evaluate the impact of Economic Policies and its implication on the Business Environment
2. Understand basic concepts of economics (demand, supply, elasticity, scarcity) and explain behaviour on individual, households and firm.
3. Handle economic data and write economic report
4. Orient students towards basic management principles and act as foundation for higher levels of learning
5. To be able to handle basic functions of management (planning, organising, coordination, and control)

Detailed Syllabus: **(per session plan)**

Unit	Description	Duration
1	Introduction: Definition of Economics, Types of economic systems, problem of scarcity of economic resources.	02
2	Demand and Supply: Demand Curve and Supply Curve, Equilibrium of Demand and Supply, Shift in Demand and Supply. Application of Demand and Supply: Price Elasticity of Demand, Price Elasticity of Supply, Factors which influence Elasticity, Elasticity and Revenue.	03

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3	Market Structure /industry analysis types of Competition: monopoly, oligopoly, monopolistic competition, perfect and imperfect competition, government policies towards industries. Circular flow of Economy, Structures, Role of Government, Business Cycles.	03
4	Macroeconomics : National Income – Gross Domestic Product (GDP), Gross National Product (GNP), Inflation – Cost Push and Demand Pull Inflation, Unemployment, Philips Curve	03
5	Functions of Central Bank Money supply, RBI & Monetary Policy.(Current Credit Policy to be critiqued) Stabilization policy : Role of fiscal Policy Demand and Consumer Behavior: Utility and Marginal Utility, Types of Goods	03
6	New economic policy :Liberalization, privatization and globalization	03
7	Theory of Production : Law of Diminishing Returns, Returns to Scale, Productivity	03
8	Analysis of Costs: Types of Costs – Total Cost, Fixed Cost, Variable Cost, Marginal Cost, Impact of Marginal Cost on Average Cost.	03
9	Introduction to Management: Management & Organizations, Management History, Understanding Management thought ,contribution of F.W. Taylor, Henry Fawol, Elton –Mayo Contexts- Constraints & Challenges	05
10	Planning: Managers as Decision makers, Foundations of Planning, Strategic Management	04
11	Organizing: Line and staff relationships ,centralization and decentralization , role of delegation ,Managing Human Resources, Managing Teams	04
12	Leading and Motivation: Basic concepts and practices –Maslows Herzberg McClealand 's theory of Achievement	04
13	Controlling: Introduction to Controlling inventory, quality control.	03
14	Orientation towards Finance, Marketing Human resources and Operation departments	02
	Total	**45**

Text Books:

1. Samuelson and Nordhaus, (2010), "Economics", *Tata McGraw Hill Publication, 19th edition.*

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2. Datt and Sundharam, (2009), "Indian Economy", S. Chand Publication, *67th edition.*
3. Koontz. H. (2012), "Essentials of Management: International and Leadership Perspective", *McGraw Hill Education (India).*
4. Collins, J. (2001), "Good to Great: Why Some Companies Makes the Leap and Other's Don't", *Random House Business Books.*

Reference Books:

1. Mankiw Gregory, (2008), "Principles of Economics", *Cengage Learning*
2. Rakesh Singh, (2007), "Analyzing Macro-Economics", *Shroff Publishers* .

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

Term work should consists of the following:

1. Assignment/Case Studies/Projects/ Presentations

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Program: B. Tech. (Mechatronics Engineering)				**Semester:** IV	
Course/ Module: Control Systems				**Module Code:** BTMA04010	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks- 100 in Question Paper)**
3	2	0	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Analog Devices and Circuits(BTMA03012), Engineering Mathematics III (BTMA03007)

Objectives:

1. To understand the basic theory of process and control systems and system stability.
2. To analyse the system design in fulfilling the performance and stability criterion.
3. To evaluate different stability criteria, controllability and observability.

Outcomes:

After completion of the course, students would be able to:

1. Identify the basic functioning and components of feedback control system.
2. Analyse processes of different orders, their dynamic and steady state response in relation to stability.
3. Compare different stability analysis criteria and conduct the test for controllability and observability.
4. Know the working principle and tuning of PID controllers.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	**Introduction to feedback control system:** Open loop and closed loop systems, servomechanisms, basic structure of a feedback control system.	02
2.	**Dynamic Models and Responses:** Dynamic model of an RLC network, impulse response model, transfer function model, standard test/ disturbance signals and their models, transfer function model and dynamic response of a second order electrical system.	06
3.	**Control System Components:** Basic units of a feedback control system, reduction of system block diagrams, signal flow graphs, Mason's gain rule, block diagram reduction using Mason's gain rule, servo potentiometer, DC and AC servomotors, tacho-generator, stepper motor, block diagram model of	08

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	a typical control system using simplified sub- system, transfer function blocks.	
4.	**Feedback Control System Characteristics:** Stability, sensitivity, disturbance rejection, steady state accuracy, transient and steady state responses of a second order system. Effect of additional zeros and pole locations and dominant poles, steady state error constants, system type numbers and error compensation	07
5.	**System Stability analysis:** System stability bounds, relative stability and range of stability, root locus concept, system characteristic equation, plotting root loci.	08
6.	**Stability Margins and State space analysis of control systems:** Gain and phase margins, bode plot of magnitude and phase and determination of stability margins. State space analysis of control systems-State space representation for electrical networks and nth order differential equations, solution of time-invariant state equation, transfer matrix, state transition matrix, controllability and observability, Kalman's test for controllability and observability for a linear time invariant continuous system.	10
7.	**Feedback System Performance:** Performance specifications in frequency domain, correlation between domain and time domain specifications. Introduction to PID controller.	04
	Total	**45**

Text Books:

1. M. Gopal (2012), "Control Systems- Principles and Design", *Tata McGraw Hill Education, 4th edition.*
2. Katsuhiko Ogata (2006), "Modern Control Engineering", *Prentice Hall of India, 5th edition.*

Reference Books:

1. I. J. Nagrath and M. Gopal (2007), "Control Systems Engineering", *New Age International Publishers, 5th edition.*

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Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	Marks
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

Term work should consists of the following:

1. Minimum two assignments.
2. Minimum ten lab experiments covering the whole syllabus, duly recorded and graded.
3. Viva voce, quizzes, Presentations based on syllabus.

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Program: B. Tech. (Mechatronics Engineering)				**Semester:** IV	
Course/ Module: Microprocessor and Microcontroller				**Module Code :** BTMA04011	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks- 100 in Question Paper)**
3	2	0	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Digital Electronics (BTMA03009)

Objectives:

1. To understand 8086 architectures.
2. To learn programming and Interfacing aspects of 8086.
3. To understand the concepts of Advanced Processors of 80386 and Pentium.
4. To understand & program 8 bit 8051 microcontroller, PIC controller and its interfacing with different devices.

Outcomes:

After completion of the course, students would be able to:

1. Know the architectural design of 8086 along with its features.
2. Design Interfacing with peripheral devices and develop programs for 8086.
3. Differentiate and compare advances in microprocessor architecture.
4. Know the microcontrollers architecture and its programming.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	**Intel 8086 microprocessor:** History and Introduction to 8086, Features of 8086, Pin Diagram, Architecture/ Programming Model, Memory organization minimum and maximum mode operation. Microprocessor family Latches 8282, clock generator 8284, Transceiver 8286. 8288 Bus Controller. Study of 8086 Instruction set. Assembly language programming, 8086 minimum and maximum mode operation with timing diagram. Interrupt-Types of interrupt, Hardware/software and program generated interrupts, Response of 8086 to interrupt, Interrupt vector Table, Priorities. Microprocessor family Latches 8282, clock generator 8284, Transceiver 8286. 8288 Bus Controller.	09
2.	**Programming of 8086:** Addressing Modes, Assembler Directives, Instruction sets of 8086,	03

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	Assembly language programming, Passing parameter to Procedure and Macro.	
3.	**Peripheral Devices and Interfacing:** 8259 Programmable Interrupt Controller, 8255 Programmable Peripheral Interface, Modes of operation of 8255, Interfacing I/O devices.	03
4.	**80386 Microprocessor:** 32 bit architecture of 80386, Segment Selector and Descriptor, Protected mode, Virtual 86 mode of operation, memory management, address translation, segmentation and segment descriptor tables (GDT and LDT). Cache Memories, Cache Architecture.	06
5.	**Introduction to Pentium Processor:** History of Evolution, Architecture of Pentium, Block Diagram, Superscalar Architecture, Branch Prediction Logic, Pipelining and Bus Operation.	04
6.	**Study of 8051 Microcontrollers**: Comparison of microprocessor and microcontroller, architecture. Applications , Pin Description, Block Diagram of 8051, Special Function registers, Internal memory organization, Program counter, Stack, Counters and Timers, Programming Timers and Counters, Serial Data Communication, Interrupts Types and Priorities, Input/output ports structure and operation.	09
7.	**Programming 8051 Microcontrollers:** Introduction to 8051 Assembly Language programming, Addressing modes and accessing memory using various addressing modes. Data Types and directives, 8051 flag bits and PSW register. Register banks and Stack. Jump loop and call instructions, I/O Port programming, Arithmetic instructions and programs, Logic instructions and programs.	03
8.	**Interfacing devices with 8051:** Interfacing with 8051 and Programming: LCD, Keyboard, ADC, DAC, PWM concept, Application-Speed Control of DC motors using PWM	04
9.	**PIC 18 Microcontrollers and ARM:** Programming model of PIC18, CPU Registers, Memory organization, Pipelining concept, PWM mode of PIC18 Introduction to embedded microcontroller core ARM family.	04
	Total	**45**

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Textbooks:

1. Badri Ram (2011), "Advanced Microprocessors and Interfacing", *Tata McGraw Hill publication*.
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay(2012), "The 8051 Microcontroller & Embedded system", *Pearson Prentice Hall, Second Edition.*
3. Han Way Huang(2009), "PIC Microcontroller", *Cengage learning.*

Reference Books:

1. Muhammad Ali Mazidi, Janice Gillespie Mazidi (2000), "The 80x86 IBM PC & compatible computers. Volumes I & II, Assembly language, design, and interfacing ", *Prentice Hall International, 2nd Edition.*
2. Kenneth Ayala (2012),"The 8051 Microcontroller", *CENGAGE Learning, 3rd Edition.*
3. A. Nagoor Kani (2012), "Microprocessor and Microcontroller", *Tata McGraw Hill publication, 2nd Edition.*
4. Douglas Hall (2006), "Microprocessors Interfacing and Programming", *Tata McGraw Hill publication.*

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

Term work should consists of the following:

1. At least ten laboratory experiments based on the entire syllabus duly recorded and graded.
2. Presentation/Application based experiment and Quiz/Practical exam/Viva/Any other mode of evaluation.

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Program: B. Tech. (Mechatronics Engineering)				**Semester :** IV	
Course/ Module: Principles of Communication Engineering				**Module Code :** BTMA04012	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks - 100 in Question Paper)**
3	2	0	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Nil

Objectives:

1. To understand concept of analog and digital modulation techniques.
2. To study different types of noise and their effect on modulation systems.
3. To understand concept of detection techniques.

Outcomes:

After completion of the course, students would be able to:

1. Analyze and compare different analog modulation schemes for their efficiency and bandwidth
2. Analyze the behaviour of a communication system in presence of noise
3. Investigate pulsed modulation system and analyze their system performance
4. Understand different digital modulation schemes and analyze different detection techniques.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	**Analog Modulation Techniques:** Concept of modulation, Comparison of Analog and digital Communication. Analog Communication -Principle of Amplitude Modulation Systems. Types of AM-DSB, SSB modulations, VSB modulation, Angle Modulation, Comparison of AM, FM and PM, Methods to generate FM-Direct and Indirect, Direct-Basic Reactance Modulator, Indirect method-Armstrong Frequency modulator, Representation of PM	12
2.	**Effects of Noise on Analog Communication Systems:** Gaussian and white noise characteristics, Noise in amplitude modulation systems, Noise in Frequency modulation systems, Pre-emphasis and De-emphasis, Threshold effect in angle modulation.	06

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3.	**Waveform Coding Techniques:** Sampling process, Quantization, Pulse Amplitude Modulation, Pulse Code Modulation, Line codes, Differential pulse code modulation, Delta modulation, Time Division multiplexing	05
4.	**Digital Modulation Techniques:** Baseband Pulse Transmission- Inter symbol, Interference and Eye pattern, Nyquist criterion, Equalization Techniques, Transversal Equalizer, Adaptive Equalizer, Pass band Digital Modulation schemes- Coherent and non-coherent communication, M-ary Phase Shift Keying- BPSK, M-ary Phase Shift Keying-QPSK, M-ary Frequency Shift Keying—Coherent BFSK M-ary Frequency Shift Keying—Non Coherent BFSK, Quadrature Amplitude Modulation, Generation and Detection of Minimum shift keying, Waveforms and phase continuity in MSK, Probability of Error for BPSK	14
5.	**Detection Techniques:** Baseband signal receiver, Probability of error, Optimum filter, Matched filter, Correlator, Concept of Maximum likelihood detection, Maximum likelihood sequence detection derivation, Synchronization for Digital modulation, Carrier Recovery for Digital modulation.	08
	Total	**45**

Textbooks:

1. Haykin S.(2010), "Communications Systems", *John Wiley and Sons.*
2. Proakis J.G.(2008), "Digital Communications'', *McGraw Hill, 5th Edition.*
3. Taub H. and Schilling D.L. (2006), "Principles of Communication Systems", *Tata McGraw Hill.*
4. George Kennedy, Bernard Davis,S R M Prasanna (2015), "Electronic Communication Systems", *McGraw Hill 5th Edition.*

Reference Books:

1. Proakis J. G. and Salehi M.(2002), "Communication Systems Engineering", *Pearson Education.*
2. Bernard Sklar (2014), "Digital Communications Fundamentals and applications", *Prentice Hall, 2nd Edition.*
3. K Sam Shanmugan (2006)," Digital and Analog communication Systems", *John Wiley & Sons.*
4. Haykin S. (2007), "Digital Communications ", *John Wiley and Sons.*

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Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

Term work should consists of the following:

1. At least ten laboratory experiments based on the entire syllabus duly recorded and graded.
2. Presentation/Application based experiment and Quiz/Practical exam/Viva/Any other mode of evaluation.

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Program: B. Tech. (Mechatronics Engineering)				**Semester:** IV	
Course/Module: Strength of Materials				**Module Code:** BTMA04013	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks-50)**	**Term End Examinations (TEE) (Marks -100 in Question Paper)**
3	2	0	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Engineering Mechanics (BTME03009)

Objectives:

1. To impart knowledge of the deformable bodies subjected to different types of loads
2. To determine the failure criteria of a body subjected to various stresses
3. To understand the concepts of deformations and identify the different tests to be performed on materials

Outcomes:

After completion of the course, students would be able to:

1. Understand the resultant stresses induced.
2. Evaluate the deformations of various determinate beams.
3. Analyze pressure vessels and power transmission systems for stability.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1	**Stress and Strain:** Strain, modulus of elasticity, modulus of rigidity, bulk modulus, yield stress, ultimate stress, factor of safety, shear stress, Poisson's ratio, analysis of members made of composite materials.	06
2	**Internal Forces & Stresses in Beams** **2.1 Shear Force and Bending Moment:** Axial force, shear force and bending moment diagrams for statically determinate beams for different types of loading. 2.2 **Simple Theory of Bending**: Flexure formula for straight beams, simple problems involving application of flexure formula, section modulus, moment of resistance of a section. 2.3 **Shear Stress in Beams:** Distribution of shear stress across plane sections used commonly for structural purposes.	17
3	**Simple Theory of Torsion:** Torsion of circular shafts – solid and hollow, stresses in power transmission shafts (including shafts in series and parallel).	04

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4	**Bending Moment Combined with Axial Loads:** Application to members subjected to eccentric loads, core of a section, problems on chimneys involving lateral loads.	05
5	**Principal Stresses:** General equations for transformation of stress, stress on an oblique plane of a member subjected to General two directional stress systems. Principal planes and principal stresses, maximum shear stress Mohr's circle concept.	05
6	**Deflection of Beams:** Deflection of cantilevers simply supported and overhanging beams using double integration and Macaulay's methods for different types of loading.	05
7	**Thin Shells:** Stresses in thin cylindrical and spherical shells subjected to internal pressure. Efficiency of Riveted Joints.	03
	Total	**45**

Text Books:

1. James M. Gere, Barry J. Goodno (2012), "Mechanics of Materials – SI Edition", *Cengage Learning*.
2. Ferdinand P. Beer, .E Russell Johnson Jr. John T. De Wolf (2008), "Mechanics of Materials", 3rd Edition, *Tata McGraw Hill*.

Reference Books:

1. Andrew Pytel, Jaan Kiusalaas (2011), "Mechanics of Materials", 2nd Edition, *Cengage Learning*.
2. William Nash, Merle Potter (2010), "Schaum's Outline of Strength of Materials, Fifth Edition", *McGraw Hill Professional*

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

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Details of Term Work:

Term work should consists of the following:

1. At least ten laboratory experiments based on the entire syllabus duly recorded and graded.
2. Presentation/Application based experiment and Quiz/Practical exam/Viva/Any other mode of evaluation

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Program: B. Tech. (Mechatronics Engineering)				**Semester:** IV	
Course/ Module: Environmental Studies				**Module Code:** BTMA04014	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks- -- in Question Paper)**
2	0	0	0	Marks Scaled to 50	--

Pre-requisite: Physics (BTMA01003), Chemistry(BTMA02010)

Objectives:

1. Introduce – Environment, Environmental Pollution,
2. Acquaint with Social Issues and methods to manage them
3. Improving Planning of activities

Outcomes:

After completion of the course, students would be able to:

1. Discuss Types of Environmental Pollution, Natural resources and its misuse, Importance of Environmental management for Construction Projects
2. Prepare plan for water management, promotion of recycle and reuse, generation of less waste, avoiding electricity waste
3. Prepare Slogan, Poster and plan activities for environmental protection and social issues

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1	Introduction to Environment and its components: Natural Resources and it Misuse leading to Environmental degradation. Role of Ecology in Environmental Degradation and Protection. Major industrial and other environmental disasters Environmental pollution- Types, Causes, Effects, Reduction methodology.	08
2	Introduction to waste generation, Methods to Reduce, Reuse and Recycle of Waste Importance of 3R's, Promotion of 3R's - Methods Solid wastes, Industrial Waste, Bio-Medical Waste and Hazardous waste management – Types, Storage, Transportation, Treatment Disposal. C&D and E-waste – Concept, methods for reduction, management Campaigning for waste reduction and management.	08
3	Concept of EIA and SIA, significance, methodology, report drafting. Environmental Management System, ISO 14000 EMS certification	05

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4	Environmental Protection, Social Issues, Disaster Management Social Issues and Environment International Conventions, Summits and Protocols Generation of less waste and avoiding electricity waste. Environmental management for construction Projects	05
5	Role of the Government in managing the environmental activities in all sectors. Organisational set up at the Central and state level to manage the environment. Role of judiciary in managing the environment. Role of Citizens, Role of NGOs/ Environmental Activists. Major Laws Air (P&C.P.) Act, Water (P & C.P) Act. Environment Protection Act EPA 1986. Wild life Protection Act etc., PIL	04
	Total	**30**

Text Books:

1. Benny Joseph (2017), "Environmental Studies", *The McGraw-Hill Companies*
2. Gerard Kiely (2007), "Environmental Engineering", *Tata McGraw-Hill Education*

Reference Books:

1. P. Aarne Vesilind, Susan M. Morgan (2004), "Introduction to Environmental Engineering", *Thomas/Brook/Cole.*
2. Mackenzie Davis, David Cornwell (2017), "Introduction to Environmental Engineering", McGraw-Hill Companies.

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

Term work should consist of the following:

1. Minimum five assignments on the above syllabus
2. Report on social issues
3. Report on Environmental Management case study

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Program: B. Tech. (Mechatronics Engineering)				**Semester :** V	
Course/Module: Elements of Biology				**Module Code:** BTMA05007	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks – 50)**	**Term End Examinations (TEE) (Marks- 100 in Question Paper)**
3	0	1	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Fundamental Knowledge of physics, chemistry and mathematics.

Objectives:

1. To provide a basic understanding of biological mechanisms of living organisms from the perspective of engineers.
2. To encourage engineering students to think about solving biological problems with engineering tools.

Outcomes:

After completion of the course, students would be able to:

1. Convey that all forms of life have the same building blocks and yet the manifestations are diverse.
2. Identify DNA as a genetic material in the molecular basis of information transfer.
3. Classify enzymes and distinguish between different mechanisms of enzyme action.
4. Apply thermodynamic principles to biological systems.
5. Identify and classify microorganisms.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	**Introduction** Convey that Biology is as important a scientific discipline as Mathematics, Physics and Chemistry Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology? Discuss how biological observations of 18th Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. These examples will highlight the fundamental importance of observations in any scientific inquiry.	**03**
2.	**Classification** Convey that classification *per se* is not what biology is all about. The underlying criterion, such as morphological, biochemical or ecological be highlighted. Hierarchy of life forms at phenomenological level. A common thread weaves this hierarchy Classification. Discuss classification based on (a) cellularity- Unicellular or multicellular (b) ultrastructure- prokaryotes or eucaryotes. (c) energy and Carbon utilization -Autotrophs, heterotrophs, lithotrophs (d) Ammonia excretion – aminotelic, uricotelic, ureotelic (e) Habitat- acquatic or terrestrial (e) Molecular taxonomy- three major	**06**

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	kingdoms of life. A given organism can come under different category based on classification. Model organisms for the study of biology come from different groups. E.coli, S.cerevisiae, D.Melanogaster, C.elegance, A. Thaliana, M.musculus	
3.	**Genetics** Convey that "Genetics is to biology what Newton's laws are to Physical Sciences" Mendel's laws, Concept of segregation and independent assortment. Concept of allele. Gene mapping, Gene interaction, Epistasis. Meiosis and Mitosis be taught as a part of genetics. Emphasis to be give not to the mechanics of cell division nor the phases but how genetic material passes from parent to offspring. Concepts of recessiveness and dominance. Concept of mapping of phenotype to genes. Discuss about the single gene disorders in humans. Discuss the concept of complementation using human genetics.	**06**
4.	**Biomolecules** *C*onvey that all forms of life have the same building blocks and yet the manifestations are as diverse as one can imagine Molecules of life. In this context discuss monomeric units and polymeric structures. Discuss about sugars, starch and cellulose. Amino acids and proteins. Nucleotides and DNA/RNA. Two carbon units and lipids.	**05**
5.	**Enzymes** Convey that without catalysis life would not have existed on earth Enzymology: How to monitor enzyme catalyzed reactions. How does an enzyme catalyze reactions? Enzyme classification. Mechanism of enzyme action. Discuss at least two examples. Enzyme kinetics and kinetic parameters. Why should we know these parameters to understand biology? RNA catalysis.	**05**
6.	**Information Transfer** The molecular basis of coding and decoding genetic information is universal Molecular basis of information transfer. DNA as a genetic material. Hierarchy of DNA structure- from single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination.	**06**
7.	**Macromolecular analysis** How to analyse biological processes at the reductionistic level Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements.	**05**
8.	**Metabolism** The fundamental principles of energy transactions are the same in physical and biological world. Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergonic reactions. Concept of Keq and its relation to standard free energy. Spontaneity. ATP as an energy currency. This should include the breakdown of glucose to CO2 + H2O (Glycolysis and Krebs cycle) and synthesis of glucose from CO2 and H2O (Photosynthesis). Energy yielding and energy consuming reactions.	**05**

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	Concept of Energy Charge.	
9.	**Microbiology** Concept of single celled organisms. Concept of species and strains. Identification and classification of microorganisms. Microscopy. Ecological aspects of single celled organisms. Sterilization and media compositions. Growth kinetics.	**04**
	Total	**45**

Text Books:

1. Arthur T. Johnson (2011) ''Biology for Engineers'' *CRC Press Taylor & Francis group.*
2. Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 2008, 7th edition McGraw-Hill Higher Education.

Reference Books:

1. Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd
2. Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H., John Wiley and Sons
3. Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work: As per institution norms.

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Program: B. Tech. (Mechatronics Engineering)				**Semester:** V	
Course/Module : Theory of Machines				**Module Code:** BTMA05008	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks- 100 in Question Paper)**
3	2	0	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: NIL

Objectives:

1. To understand the basics of links, mechanisms and machines.
2. To provide knowledge of motion analysis of mechanisms and machine components like clutch, brakes, flywheel and gyroscope.
3. To introduce different types of cam and follower system.
4. To impart knowledge of various types of gear and gear-train.

Outcomes:

After completion of the course, students would be able to:

1. Understand the concept of kinetics, kinematics inversion of chains, friction clutches, brakes, dynamometers and gyroscopic couple.
2. Calculate the static and dynamic forces of flywheel, velocity and acceleration of given mechanisms graphically.
3. Construct various type of Cam profiles and analyze the standard motion of the follower.
4. Compare different type of gears and design gear-trains for different applications.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	**Kinematics:** Basics (Mechanism and Machines, Rigid and resistant body, Link), Classification Kinematics pairs), Based on relative motion permitted such as revolute, prismatic, cam, helical Globular. Grubler's criterion and Grasshof's criteria. **Inversion of chain:** mechanisms, quick return mechanism, applications. Four bar chain, Single slider crank chain, Double slider crank chain. **Special Mechanisms**: Straight line generating Mechanisms	**08**
2.	**Velocity and Acceleration analysis: (Graphical approach)** **Velocity analysis:** instantaneous center of rotation method, relative velocity method, rubbing velocities at joints, mechanical advantage. **Acceleration analysis**: relative method including kinematic pairs, Coriolis components of acceleration.	**08**
3.	**Friction Clutches:** Single and multiple plate clutch, Cone clutch, Centrifugal clutch, Torque transmitting capacity. **Brakes and Dynamometers:** Types of Brakes, absorption and transmission dynamometers. **Flywheel:** Turning moment, function of flywheel, estimating inertia of flywheel for reciprocating prime movers and machines.	**08**

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4.	**Cams and Followers:** Types of cams and followers, analysis of standard motions to the follower, determination of cam profiles for given follower motions, analysis of cams with specified contours- circular arc cam, tangent cam, eccentric cam, kinematically equivalent system, jump phenomenon,	**08**
5.	**Gears and Gear trains:** Definition, Classification of gears and Law of gearing **Spur Gears**: Terminology, conjugate action, involute and cycloidal profile, path of contact, arc of contact, contact ratio, interference, undercutting, Methods to avoid interference and undercutting, Rack and pinion. Helical Gears, Spiral Gears, Worm gears, Bevel Gears, rack and pinion gears. **Gear trains:** Types of gear trains (Simple, compound and epicyclic). Velocity ratio.	**07**
6.	**Gyroscope:** Principle, gyroscopic couple, effect of gyroscopic couple on stability of an automobile, gyroscopic effect on two wheelers, four wheels and aero planes.	**06**
	Total	**45**

Text Books:

1. Thomas Beven (2009), "Theory of Machines**",** 3rd Edition, *Pearson*.
2. S. S. Rattan (2009), "Theory of Machines", 3rd Edition, *Tata McGraw Hill, New Delhi*.

Reference Books:

1. John Uicker, G R Pennock J. E. Shigley (2010), "Theory of Mechanisms and Machines", 3rd Edition, *University Press*.
2. P. L. Ballaney (2005), "Theory of Machines and Mechanisms", 24th Edition, *Khanna Publishing, New Delhi*.
3. Ghosh and Malik (1988). "Theory of Mechanisms and machines", East West press Pvt. Ltd.

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	Marks
Test Marks	20
Term Work Marks	30
Total Marks :	50

Details of Term work:

Term work should consist of the following:

1. Assignments given by the faculty based on above syllabus (Min. 3).
2. Minimum 6 experiments based on above syllabus
3. Viva Voce or Multiple Choice Questions (MCQ) Examination.

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Program: B. Tech. (Mechatronics Engineering)				**Semester:** V	
Course/Module: Industrial Electronics and Drives				**Module Code:** BTMA05009	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks- 100 in Question Paper)**
3	2	0	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Basic Electrical Engineering (BTMA01002) and Analog Devices and Circuits (BTMA03012)

Objectives:

1. To understand the operation of power semiconductor devices.
2. To study converter circuits for AC-DC and AC-AC power conversion.
3. To study AC, DC & synchronous motor drive circuits.
4. To design drives and regulatory circuits used in power electronic industry.
5. To expose students to simulation tools for power electronic circuit analysis.

Outcomes:

After completion of the course, students would be able to:

1. Know power electronic semiconductor devices for different applications.
2. Analyze and design power electronic circuits for industrial applications.
3. Understand the significance of drives and regulator circuits used in power electronic industry.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	**Power Devices:** Construction, Static and Dynamic characteristics and ratings of SCR, GTO, IGBT, DIAC and TRIAC. Methods of turning on of SCR- Gate triggering circuit using UJT. Methods of turning off-Commutation circuits	**08**
2.	**Power Converters:** **Single phase and three phase Converters:** Circuit diagram, operation and waveforms for R and R-L loads of single phase and three phase controlled rectifiers using controlled devices. **Cycloconverter:** Circuit Diagram, basic principle of operation and waveforms of single phase to single phase cycloconverter (Bridge configuration only)	**07**
3.	**DC Drives:** Basic Characteristics of DC motors - Operating Modes Single Phase Drives-Half wave converter Drives, Semi converter Drives, Full Converter Drives, Dual Converter Drives. Three Phase Drives-Half wave converter Drives, Semi converter Drives, Full Converter Drives, Dual Converter Drives. Chopper Drives-Principle of Power Control, Principle of Regenerative Brake Control, Principle of Rheostatic Brake Control, Two/Four Quadrant Chopper Drives.	**14**

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	Closed Loop Control of DC Drives- Open Loop Transfer Function, Closed Loop Transfer Function, Phase Locked Loop Control, Microcomputer Control of DC Drives.	
4.	**AC Drives**: Introduction, Induction Motor Drives, Performance Characteristics, Stator Voltage Control, Rotor Voltage Control, Slip power recovery, Frequency Control, Voltage and Frequency Control, Current Control, Voltage, current and Frequency Control, Closed-Loop Control of Induction Motors.	**09**
5.	**Synchronous Motor Drives**: Cylindrical Rotor Motors, Salient-Pole Motors, Reluctance Motors, Permanent-Magnet Motors, Switched Reluctance Motors, Closed-Loop Control of Synchronous Motors, Brushless DC and AC Motor Drives	**07**
Total		**45**

Text Books:

1. M. Rashid, "Power Electronics", Prentice Hall of India Publication, 3rd Edition, 2010.
2. M. D. Singh & K. B. Khanchandani, "Power Electronics", Tata McGraw Hill, 2nd edition, 2006.
3. Dubey G.K, "Fundamentals of Electrical Drives", Narosa Press, 2nd Edition, 2002

Reference Books:

1. Ned Mohan, Undeland Robbins, "Power Electronics", John Wiley Publication year, 3rd Edition, 2009
2. Landers, "Power Electronics", McGraw Hill, 3rd Edition, 1993.

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

Term work should consist of the following:

1. Minimum two assignments.
2. Minimum ten experiments covering the whole of syllabus, duly recorded and graded.
3. Two term test papers.

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Program : B. Tech. (Mechatronics Engineering)				**Semester :** V	
Course/Module: Essence of Indian Traditional Knowledge				**Module Code :** BTMA05010	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks - --- in Question Paper)**
2	0	0	0	Marks Scaled to 50	---

Pre-requisite: NIL

Objectives:

1. This course provides introduction to Indian traditional knowledge and its relevance in the modern society.

Outcome:

After completion of the course, students would be able to:

1. Understand the concept of Traditional knowledge and its importance
2. Apply the concept of Vedic mathematics to solve problems
3. Understand relevance of Chanakya niti in modern management

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	**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	**05**
2.	**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.	**05**
3.	**Vedic mathematics:** Introduction, subtraction, multiplication, division, linear and quadratic equations, simultaneous linear equations, factorizations	**10**
4.	**Chanakya and modern management:** leadership, qualities of a leader, people management, strategy, teamwork	**10**
	Total	**30**

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Text Books:

1. R. Pillai, Corporate Chanakya, Jaico Publishing House: Mumbai, 2012.
2. S. B. K. Tirtha and V. S. Agrawala, Vedic Mathematics, New Delhi: Motilal Banarsidass, 2004.
3. A. Jha, Traditional Knowledge System in India, New Delhi: Atlantic Publishers and Distributors (P) Ltd, 2009.

Reference Books:

1. D. Bathia, Vedic Mathematics Made Easy, Mumbai: Jaico Publishing House, 2014.
2. B. K. Mohanta and V. K. Singh, Traditional Knowledge System and Technology in India, Delhi: Pratibha Prakashan, 2012.
3. S. Bose, Vedic Mathematics, V&S Publishers: New Delhi, 2015.

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**---**
Term Work Marks	**50**
Total Marks :	**50**

Details of Term work: As per Institute norms.

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Program : B. Tech. (Mechatronics Engineering)				**Semester :** V	
Course/Module: Management Accounting for Engineers				**Module Code :** BTMA05011	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks - 100 in Question Paper)**
2	---	---	2	Marks Scaled to 50	Marks Scaled to 50

Prerequisite: Nil

Objectives:

1. To provide conceptual understanding of Cost and Management Accounting principles and practices relevant for business analysis and decision making.
2. To develop the ability to understand, analyze and use cost information in day-to-day business functioning.
3. To provide an understanding of measurement of cost and tracing the costs to products and customers.
4. To explain the role of relevant costs in decision making and developing better strategies.
5. To discuss contemporary issues in Cost and Management Accounting and their practical applications.

Outcomes:

After completion of this course, participants should be able to;

1. Understand the principles of various Costing methods viz., Activity Based Costing (ABC) Method, Job and Process Costing Methods.
2. Preparation of cost sheet
3. Apply Cost-Volume-Profit Analysis in business decision making.
4. Analyze Price and Cost Variances
5. Using budgetary control techniques for managerial decision making
6. Apply different methods of Inventory management
7. Apply Activity Based Costing to generate reliable and accurate product cost data

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1	Topic: Introduction to Cost accounting and Cost concepts: • Interface of Financial accounting with Cost accounting – • Methods of costing • Types of Costing • Classification of Costs based on Behaviour	2

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	• Classification of Costs based on Behaviour Readings: Cost accounting. 5/e, Lal. J., & Srivastava, S. (2013). New Delhi, Tata McGraw Hill – Chapter1 and 2 Outcome addressed 1	
2	Topic: Cost Concepts • Classification of Costs based on Degree of Traceability to the product • Functional Classification of Costs • Costs for Decision making and planning Readings: Cost accounting. 5/e, Lal. J., & Srivastava, S. (2013). New Delhi, Tata McGraw Hill - Chapter 2 Outcome addressed 1	2
3	Topic: Preparation of Cost sheet Readings: Cost accounting. 5/e, Lal. J., & Srivastava, S. (2013). New Delhi, Tata McGraw Hill - Chapter 2 Outcome addressed 2	2
4	Topic: Cost-Volume-Profit Analysis: • Concept of Marginal Costing • Cost-Volume-Profit relationship – • The break-even point – Readings: Cost accounting. 5/e, Lal. J., & Srivastava, S. (2013). New Delhi, Tata McGraw Hill - Chapter 16 Outcome addressed 3	2

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5	Topic: Cost-Volume-Profit Analysis: • Contribution margin concept – • Margin of safety Readings: Cost accounting. 5/e, Lal. J., & Srivastava, S. (2013). New Delhi, Tata McGraw Hill - Chapter 16 Outcome addressed 3	2
6	Topic: Cost-Volume-Profit Analysis: • Applying cost-volume-profit analysis – Readings: Cost accounting. 5/e, Lal. J., & Srivastava, S. (2013). New Delhi, Tata McGraw Hill - Chapter 16 Outcome addressed 3	2
7	Topic: Decisions making: • Alternative choice decisions – • Limiting factor decisions • Add or drop products Readings: Cost accounting. 5/e, Lal. J., & Srivastava, S. (2013). New Delhi, Tata McGraw Hill - Chapter 17 Outcome addressed 3	2

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8	Topic: Decisions making: • Make or Buy decisions • Shut down decision • Special orders Readings: Cost accounting. 5/e, Lal. J., & Srivastava, S. (2013). New Delhi, Tata McGraw Hill - Chapter 17 Outcome addressed 3	2
9	Topic: Variance analysis- • Direct material variances • Cost Variance • Price Variance • Usage Variance Readings: Cost accounting. 5/e, Lal. J., & Srivastava, S. (2013). New Delhi, Tata McGraw Hill - Chapter 19 Outcome addressed 4	2
10	Topic: Variance analysis- • Direct labour variances • Cost Variance • Rate Variance • Efficiency Variance Readings: Cost accounting. 5/e, Lal. J., & Srivastava, S. (2013). New Delhi, Tata McGraw Hill - Chapter 19 Outcome addressed 4	2

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11	Topic: Budgetary Control • Flexible Budget Readings: Cost accounting. 5/e, Lal. J., & Srivastava, S. (2013). New Delhi, Tata McGraw Hill - Chapter 20 Outcome addressed 5	2
12	Topic: Budgetary Control • Cash Budget Readings: Cost accounting. 5/e, Lal. J., & Srivastava, S. (2013). New Delhi, Tata McGraw Hill - Chapter 20 Outcome addressed 5	2
13	Topic: Inventory Management • EOQ • Inventory levels- Minimum, Maximum, Re-order, Average • Inventory control Techniques- ABC Analysis, JIT method Readings: Cost accounting. 5/e, Lal. J., & Srivastava, S. (2013). New Delhi, Tata McGraw Hill - Chapter 3 Outcome addressed 6	2
14	Topic: Activity Based Costing • under costing and over costing- • traditional vs activity-based costing-	2

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	• Evaluation of costs and benefits of implementing ABC systems Readings: Cost accounting. 5/e, Lal. J., & Srivastava, S. (2013). New Delhi, Tata McGraw Hill - Chapter 8 Outcome addressed 7	
15	Topic: Activity Based Costing • Application of Activity based costing in decision making Readings: Cost accounting. 5/e, Lal. J., & Srivastava, S. (2013). New Delhi, Tata McGraw Hill - Chapter 8 Outcome addressed 7	2
	Total	**30**

Text Book :
Cost accounting. 5/e, Lal. J., & Srivastava, S. (2013). New Delhi, Tata McGraw Hill.

Reference Books :

- Horngren, C., Datar, S. & Rajan, M. (2014). *Cost accounting: A managerial emphasis.* 15/e, New Delhi, Pearson Publication.
- Khan, M.Y., & Jain, P.K. (2007). *Cost accounting*. 7/e, New Delhi, Tata Mc- Graw Hill.
- Ramanathan, S. (2014). *Accounting for Management.* New Delhi, Oxford University Press.
- Shah, P. (2012). *Management Accounting*. 7/e, New Delhi, Oxford University Press.
- Sanyers, J., & Jenkins, & Arora. (2012). *Managerial Accounting*. 1/e, Delhi, Cengage Learning.

Internet References :

http://icmai.in

https://www.cimaglobal.com

Any other information:

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Detail of Test: Questions based on concepts, applications and numerical

MT-01: Scope: Topics from Unit - 01 to 06 for 10 Marks
MT-02: Scope: Topics from Unit - 07 to 09 for 10 Marks

Test Marks – 20 Marks
Term Work – 30 Marks

Details of Term work: Projects/Presentations application of concepts from on Unit 01 to Unit 15.

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Program: B. Tech. (Mechatronics Engineering)				**Semester :** V	
Course/ Module: Electro-Mechanical Workshop				**Module Code:** BTMA05012	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks- --- in Question Paper)**
0	2	0	1	Marks Scaled to 50	----

Pre-requisite: Workshop Practice (BTAB02006)

Objectives:

1. To provide hands on training to students on concepts of Mechatronics.

Outcomes:

After completion of the course, students would be able to:

1. Perform different operations on Machine Tools
2. Identify various components of Mechatronics for specific applications.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	Introduction to Machine Shop & jobs using various machining processes.	**10**
2.	Introduction to different components of Mechatronics for implementation of a Minor Project based on Microprocessors/ Motors/ Digital Circuits/ Electronic Devices/ Hydraulic or Pneumatic Drives/PLC programming.	**20**
	Total	**30**

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**---**
Term Work Marks	**50**
Total Marks :	**50**

Details of Term work: As per norms

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Program: B. Tech. (Mechatronics Engineering)				**Semester:** V	
Course/ Module: (Professional Elective Course-1) Thermodynamics and Heat Transfer				**Module Code:** BTMA05013	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks- 100 in Question Paper)**
3	2	0	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Physics (BTMA01003), Mathematics-I (BTMA01001),Mathematics-II (BTMA02008) Mathematics – IV (BTMA04008)

Objectives:

1. To introduce thermodynamic concepts, thermodynamic properties and thermodynamic definitions of heat and work.
2. To make students aware of laws of thermodynamics and their applications to engineering problems.
3. To introduce the broad-based understanding of different modes of heat transfer.
4. To impart knowledge of different applications of conduction, convection and radiation.

Outcomes:

After completion of the course, students would be able to:

1. Know the fundamental concepts of engineering thermodynamics.
2. Analyze closed systems, steady and unsteady flow open systems based on first law of thermodynamics(energy), second law of thermodynamics(entropy).
3. Proficiently apply heat transfer principles (conduction, convection and radiation) to modeling and solution of engineering problems including analytical and numerical solutions to governing equations.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	**Introduction:** Definition, and basic concepts of engineering thermodynamics; description of matter – macroscopic description and microscopic description; thermodynamic system, surroundings and the system boundary; thermodynamic properties, processes and cycles; homogeneous and heterogeneous systems; thermodynamic equilibrium; quasi-static process; pure substance; concepts of continuum. **Pressure, Volume and Temperature:** definition of pressure**,** volume and temperature and their measurements; Thermal equilibrium; Zeroth law of thermodynamics; – thermometric property, scale of temperature, reference points, comparison of different types of thermometers; ideal gas; gas thermometers; ideal gas temperature; Celsius temperature scale; illustrative Examples.	**06**
2.	**First Law of Thermodynamics:** Definition of the first law; Application of first law for a closed system undergoing a cyclic and non-cyclic process; different forms of stored energy; pure substance; specific heats,	**03**
3.	**Second Law of Thermodynamics:** Limitations of first law; Kelvin-Planck	**06**

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	statement of second law; Clausius statement of second law; equivalence between the two statements; reversibility and irreversibility- definition of a reversible heat engine; Statement of Third Law of Thermodynamics and its importance	
4.	**Entropy:** Introduction; Clausius inequality (or Clausius theorem); Entropy as a property of a system; Temperature – entropy plot and its usefulness in analyzing thermodynamic processes; entropy change for an irreversible process; principle of increase of entrop; Carnot cycle, entropy generation in closed and open systems; Tds relations and their significance(first and second law combined), Isentropic process.	**06**
5.	**Basic Concepts** Modes of Heat Transfer, its mechanism and mathematical model. **Conduction Heat Transfer:** Fourier's general conduction equation in Cartesian, cylindrical and spherical co-ordinates, thermal resistance, Solution of Fourier's equation for one dimensional steady state heat conduction through various configurations such as plane, cylindrical, spherical wall, composite medium.(for cylindrical and spherical walls derivation of Fourier's three-dimensional equation is not included), Critical thickness of insulation and its importance **Heat Transfer from extended surfaces:** Types of fins, Governing equation, fin effectiveness, efficiency of fin, concept of corrected fin length, application of fins.	**12**
6.	**Unsteady State Heat Conduction:** Lumped System Analysis, Heat Transfer in Semi Infinite solids, Use of Transient-Temperature Charts. **Convection Heat Transfer:** Classification of convection heat transfer- Forced & Natural, Hydrodynamic and thermal boundary layer, Momentum and energy equation for laminar boundary layer, Laminar and Turbulent flow. Convection heat transfer coefficient, Boundary layer similarities	**08**
7.	**Thermal Radiation:** Introduction to Physical Mechanism, concept of black body, and grey body, radiation properties. Basic laws of radiation- Planck's law, Kirchoff's law, Stefan-Boltzman law, Wein's-displacement law and Lambert's Cosine law	**04**
	Total	**45**

Text Books:

1. P. K. Nag, "Engineering Thermodynamics", Tata McGraw Hill, 2008
2. Fundamentals of Heat and Mass Transfer (2017) by Theodore Bergman & Adrienne Lavine, 8th edition, Wiley Publication

Reference Books:

1. Y. Cengel and M. Boles, "Thermodynamics -An Engineering Approach", Tata McGraw Hill, 2008.
2. Introduction to Thermodynamics and Heat Transfer by Yunus A. Cengel McGraw-Hill,.

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Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	Marks
Test Marks	20
Term Work Marks	30
Total Marks :	50

Details of Term work:

Term work should consist of the following:

1. Assignments given by the faculty based on above syllabus (Min. 3).
2. Two term test papers.
3. Minimum 6 experiments based on the above syllabus

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Program: B. Tech. (Mechatronics Engineering)				**Semester:** V	
Course/Module: (Professional Elective Course-1) Materials Engineering				**Module Code:** BTMA05014	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks-50)**	**Term End Examinations (TEE) (Marks -100 in Question Paper)**
3	2	0	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Physics (BTMA01003), Chemistry (BTMA02010)

Objectives:

1. To learn the fundamental science and engineering relevant to materials
2. To introduce the concept of mechanical deformation in metals
3. To impart the knowledge of various failure mechanisms in materials and the theories and design modifications to avoid them.

Outcomes:

After completion of the course, students would be able to:

1. Design a process, microstructure and components to satisfy the system requirements.
2. Analyze the root cause of failure in different types of materials.
3. Understand formation of alloys and their applications.
4. Select appropriate materials for various applications depending on the structural requirements.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	**Mechanical Behaviour of Metals:** **Deformation:** Definition, elastic and plastic deformation and significance in design and shaping deformation in single crystal and polycrystalline materials, critical stress for deformation. **Material Testing: Destructive Testing:** Basic mechanical properties, tensile testing, hardness testing, Impact testing. **Non Destructive Testing:** Dye Penetrant, magnetic particle and ultrasonic testing **Strain Hardening:** Definition and importance, dislocation theory, effect of strain hardening on engineering behaviour of material. Recrystallization annealing, recovery, recrystallization and grain growth.	**10**
2.	**Failure of Metals:** **Fracture:** Definition and types, Griffth's theory of fracture, Orowan's Modification. **Fatigue:** Definition and significance of cyclic stress, mechanism of fatigue and theories of fatigue failure, S-N curve and its interpretation, Notch effect, surface effect, Corrosion and thermal fatigue. **Creep:** Definition and significance of creep, analysis of classical creep curve, creep resistant materials	**08**

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3.	**Phase Diagrams:** Concept of solidification of metals, Solidification of pure metals, solid solutions, nucleation, growth of the new phase, solidification of alloys, progressive and directional solidification. phases and structural constituent of phase diagram, Gibb's phase rule, Lever rule. Coring and dendritic segregation, Eutectic and eutectoid system.	**04**
4.	**Fe-Fe_3C Equilibrium Diagram:** Importance of iron as engineering material, Allotropic forms of irons, **Fe-Fe_3C diagram:** phases, reactions, and critical temperatures Solidification and microstructure of different steels **Effect of Alloying Elements in Steels:** Limitation of plain carbon steels. Significance of alloying elements. **Cast irons:** White, gray and malleable cast iron, Nodular and mottled cast iron, Alloy cast iron	**07**
5.	**Heat Treatment of Steel:** Definition and significance of heat treatment, Time temperature transformation diagrams (TTT), Continuous cooling Transformation (CCT). **Annealing:** Process, properties and applications of full annealing, diffusion annealing, process Annealing and cyclic annealing. **Normalizing**: **Hardening and Tempering.**	**07**
6.	**Powder Metallurgy:** Characteristics and production of metal powders, blending and mixing, compacting, pre-sintering and sintering secondary operations	**02**
7.	**Engineering Alloys** **Ferrous Alloys:** Classification, stainless steel, Tool Steel. **Non-ferrous alloys**: Copper alloys: Brass, bronzes (Tin, Beryllium and Silicon), Aluminium and its alloys. **Composite Materials** Definition, Characteristics and applications of composite materials **Introduction of Advance and Smart Materials.**	**07**
	Total	**45**

Text Books:

1. Willam D. Callister, Jr., Adopted by R. Balsubramanium (2012), "Material science and Engineering", Wiley India (P) Ltd.
2. S. H. Avner (2012), "Introduction to Physical Metallurgy", Tata McGraw Hill.

Reference Books:

1. V.D. Kodgire, S.V. Kodgire (2003) "Material science and Metallurgy" Everest Publishing House, Pune.
2. K.G. Budinksi & M.K. Budinksi (2016), "Engineering materials Properties and Selection", Pearson India Education Service Pvt. Ltd.

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Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term Work:

Term work should consist of the following

1. A report on minimum 6 experiment based on the above syllabus
2. Minimum two assignments covering the syllabus

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Program : B. Tech. (Mechatronics Engineering)				**Semester :** V	
Course/Module: (Professional Elective Course-1) Fluid Mechanics & Machinery				**Module Code :** BTMA05015	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks -** 50**)**	**Term End Examinations (TEE) (Marks -** 100 **in Question Paper)**
3	2	0	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Physics (BTMA01003), Mathematics-I (BTMA01001), Mathematics-II (BTMA02008) Mathematics – IV (BTMA04008)

Objectives:

1. To impart the knowledge of structure and properties of fluid and appreciate the complexities in solving fluid problems.
2. To provide understanding of various flow measurement techniques.
3. To impart the knowledge of characteristics of the components of fluid machines.

Outcomes:

After completion of the course, students would be able to:

1. Understand fluid properties, and their static-dynamic nature,
2. Apply fundamentals of laminar and turbulent flow, boundary layer theory in solving real life problem
3. Analyze the flow in water pumps and turbines

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	**Fluid Properties:** Concept of continuum, fluid properties, Classification of fluid, Newton's law of viscosity, stress-strain relationship. **Fluid Statics**: Basic hydrostatic equation, Pascal's Law, application to Manometers and mechanical gauges, hydrostatic forces on plane and curved submerged surfaces. **Buoyancy and Floatation:** Archimedes' Principle, buoyancy force and center of buoyancy, metacenter, metacentric height, analytical method to find metacentric height, condition of equilibrium of submerged bodies, oscillation of a floating body	**10**
2.	**Fluid Kinematics:** Description of fluid motion-Lagrangian method and Euler's method, classification of flow types- steady and unsteady, uniform and non-uniform, laminar and turbulent, one two and three-dimensional flow, rotational and irrotational, laminar and turbulent, compressible and incompressible.	**05**
3.	**Fluid Dynamics:** Euler's equation of motion, Bernoulli's equation and its applications-Venturimeter, orifice meter, rotameter, pitot tube, Impulse-Momentum equation and its applications, Reynolds Transport Theorem and its application.	**03**

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4.	**Laminar Flow:** Navier-Stokes equation of motion, developing expression for flow rate, pressure drop, shear stress, friction factor. Flow of viscous fluid in circular pipes. **Turbulent Flow**: Shear stresses in turbulent flow, theories of turbulent shear stress, hydro-dynamically smooth and rough surface, modeling of turbulence. **Flow through pipes:** Energy losses in pipes: Minor and Major losses, Darcy-Weisbatch equation for head loss in pipes, hydraulic gradient lines, and total energy lines, pipes in series and parallel.	**07**
5.	**Principles of hydraulic machines:** Impacts of jet on flat plate and cured vanes, elements of a hydro power plant, types of heads and efficiencies. Theory of impulse and reaction machines, Euler's energy equation applied to a turbine and pump, velocity triangles, expression for work done.	**04**
6.	**Impulse Turbines & Reaction Turbines** Construction, working and performance of Pelton turbine, Francis Turbine and Kaplan Turbine	**06**
7.	**Pumps:** Introduction, Classification of pumps - positive displacement and non - positive displacement. **Reciprocating Pump:** Basic theory, construction, operation, Slip, Indicator diagram. Types of reciprocating pumps, use of air vessel. **Rotary Pumps:** Basic theory, types, construction and working, variable delivery pumps. **Centrifugal pumps:** Basic Theory, Euler's equation and velocity triangles, classification, construction, operation, characteristics Priming of pumps and NPSH Theory, Construction and working of Air lift pump, Jet pump and Hydraulic Ram.	**10**
	Total	**45**

Text Books:

1. Frank M. White (2008), "Fluid Mechanics", 6th Edition, *McGraw Hill*.
2. S.K. Som, Biswas G., "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw-Hill, 2nd Edition, 2008
3. Yunus A. Cengel and John Cimbala (2008), "Fluid Mechanics", 2nd Edition, *Tata McGraw Hill*.

Reference Books:

1. John F. Douglas, Janusz Gasiorek (2001), "Fluid Mechanics", 4th Edition, *Pearson Education*.
2. P. N. Modi and S.M. Seth(2015), Fluid Mechanics and Hydraulic Machinery, Standard Book House, 22nd Edition.

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Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

Term work should consist of the following:

1. Assignments given by the faculty based on above syllabus (Min.3).
2. Minimum 6 experiments based on the above syllabus
3. Two term test papers.

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Program: B. Tech. (Mechatronics Engineering)				**Semester :** V	
Course/ Module: (Professional Elective Course-2) Industrial Data Communication				**Module Code:** BTMA05016	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks- 100 in Question Paper)**
3	2	0	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Principles of Communication Engineering (BTMA04012)

Objectives:

1. To create awareness about the OSI reference model.
2. To acquaint the students with the different types of networks at various levels such as sensor level, device network and control network.
3. To provide sufficient knowledge about the HART.
4. To impart the fundamentals of foundation field bus.

Outcomes:

After completion of the course, students would be able to:

1. Examine the importance of OSI, TCP/IP model, various networking components.
2. Compare the different types of networks at various levels of field communication.
3. Use HART for communication
4. Establish Foundation fieldbus communication.
5. Investigate the various wireless devices.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	**Introduction to Networks:** OSI reference model**,** TCP/IP model, Transmission media, UTP-STP cable, co-axial cable, N/W components: Repeaters, bridge, hub, switch, router, gateways.	**07**
2.	**Open Control Network:** RS232, RS422, EIA485 , Modbus Structure, Implementation, GPIB, Proprietary Control N/Modbus Plus.	**08**
3.	**Networks at different levels:** Sensor level network: AS-i, CAN, Device net, Interbus and LON Device networks: Foundation Fieldbus H1-HART Profibus-PA Control Network: BACnet, control-net, FF-HSE, Profibus-DP.	**08**
4.	**HART:** Architecture, Physical, Data Link, Application, Communication Technique, Normal and burst mode of communication, Troubleshooting, Benefits of HART	**08**
5.	**Foundation Fieldbus:** Fieldbus requirement, features, advantages, fieldbus components, types, architecture–physical, data link, application layer, system and network management, wiring, segment functionality checking, installation in safe and hazardous area and troubleshooting, function block application process.	**08**

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6.	**Wireless Technologies:** Satellite systems, Wireless LANs (WLANs), WiFi, VPAN, 6LoWPAN, ZigBee/IEEE 802.15.4 protocol, Bluetooth Low Energy (BLE), GPRS and – their comparison, limitations and characteristics.	**06**
	Total	**45**

Text Books:

1. Deon Reynders, Steve Mackay, Edwin Wright, Practical Industrial Data Communication, 1st edition ELSEVEIR, 2005.
2. Lawrence M Thompson, Industrial Data Communication, 2nd edition, 1997.

Reference Books:

1. Daniel T Miklovic, Real Time Control Networks, ISA 1993.
2. Bela G Liptak, Process Software and Digital Networks,3rd edition2002.
3. Andrew S. Tanenbaum, Computer Networks, 4th edition, PHI/Pearson Education,2002.
4. Behrouz A. Forouzan, Data Communications and Networking, 2nd edition, Tata McGraw Hill Publishing Company, New Delhi, 2000.
5. Douglas E.Corner, Computer Networks and Internets, 2nd edition, Pearson Education Asia, 5th Indian reprint, 2001.

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

Term work should consist of the following:

1. At least ten laboratory experiments based on the entire syllabus duly recorded and graded.
2. Presentation/Application based experiment and Quiz/Practical exam/Viva/Any other mode of evaluation.

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Program: B. Tech. (Mechatronics Engineering)				**Semester :** V	
Course/ Module: (Professional Elective Course-2) Python Programming				**Module Code:** BTMA05017	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks- 100 in Question Paper)**
3	2	0	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Programming for Problem Solving (BTMA02009)

Objectives:

1. To know the basics of algorithmic problem solving
2. To develop Python programs with conditionals and loops.
3. To define Python functions and call them.
4. To use Python data structures and input/output with files in Python.

Outcomes:

After completion of the course, students would be able to:

1. Develop algorithmic solutions to simple computational problems
2. Decompose a Python program into functions.
3. Represent compound data using Python lists, tuples, dictionaries.
4. Read and write data from/to files in Python Programs.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	**Algorithm Problem Solving:** Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.	**08**
2.	**Data, Expressions, Statements:** Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.	**10**
3.	**Control Flow, Functions:** Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.	**10**

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4.	**Lists, Tuples, Dictionaries:** Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, merge sort, histogram.	**09**
5.	**Files, Modules, Packages:** Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.	**08**
	Total	**45**

Text Books:

1. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016.
2. Guido van Rossum and Fred L. Drake Jr, An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.

Reference Books:

1. Robert Sedgewick, Kevin Wayne, Robert Dondero, ―Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.
2. Timothy A. Budd, ―Exploring Python‖, Mc-Graw Hill Education (India) Private Ltd.,, 2015.
3. Kenneth A. Lambert, ―Fundamentals of Python: First Programs‖, CENGAGE Learning, 2012.
4. Charles Dierbach, ―Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	Marks
Test Marks	20
Term Work Marks	30
Total Marks :	50

Details of Term work:

Term work should consist of the following:

1. At least ten laboratory experiments based on the entire syllabus duly recorded and graded.
2. Presentation/Application based experiment and Quiz/Practical exam/Viva/Any other mode of evaluation.

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Program: B. Tech. (Mechatronics Engineering)				**Semester :** V	
Course/ Module: (Professional Elective Course-2) Signals and Systems				**Module Code:** BTMA05018	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks- 100 in Question Paper)**
3	2	0	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Mathematics-III (BTMA03007)

Objectives:

1. To provide knowledge of analog domain signals and systems for time and frequency domain analysis.
2. To study various continuous and discrete time transforms.

Outcomes:

After completion of the course, students would be able to:

1. Define and identify various types of signals and systems.
2. Apply mathematical operations to analyze signals and systems.
3. Apply various mathematical transforms for continuous time signal and systems.
4. Use various transforms to analyze discrete time signal and systems.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	**Signals:** Signals, classification of signals, elementary signals - analog and discrete signals, Basic operation of signals, systems.	**04**
2.	**Time domain representation for linear time invariant systems (analog & discrete):** Classification of systems, series and parallel connection of systems, causal, non-causal, memory less and with memory, stable invertible systems. Convolution. Impulse, step response for first and second order LTI systems.	**07**
3.	**Fourier Series for continuous time and discrete time signals:** Representation of signals in terms of orthogonal functions, orthonormal signals, Types Fourier series – Exponential and Trigonometric Fourier Series. Dirichlet Conditions. Gibb's Phenomenon.	**08**
4.	**Fourier Transform for continuous time signals:** Fourier transform, their properties, Fourier transform representation of periodic signals. Frequency response of continuous time system. Relation between Fourier and Laplace Transform.	**06**
5.	**Analysis of continuous time system using Laplace transforms:** Introduction to bidirectional Laplace transforms and ROC, its properties, Application of LT in electrical circuit , LT of elementary signals unilateral Laplace transform Inversion of Laplace transform, Using L.T. with or without initial conditions, Transfer function of system.	**08**

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6.	**Analysis of discrete time system using Z transforms:** Introduction, Z transform of elementary signals, ROC, Properties of Z transform, Inversion of Z transform, system function, solution of difference equation, unilateral Z transform.	**12**
	Total	**45**

Text Books:

1. Tarun Kumar Rawat, Signals and Systems, Oxford University Press, July-2010.
2. Nagoor Kani , Signals and Systems, McGraw-Hill publication, 1st Edition, March-2010.

Reference Books:

1. Oppenheim & Willsky, Signal and Systems, Prentice Hall of India publication, 2nd edition, 2008.
2. Simon Haykin & Barry van veen, Signal and Systems, John Wiley publication. 2nd edition, 2008.
3. H. P. HSU, Signals and Systems, Schaum's Outlines, McGraw-Hill publication, 3rd Edition, 2013.

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

Term work should consist of the following:

1. At least ten laboratory experiments based on the entire syllabus duly recorded and graded.
2. Presentation/Application based experiment and Quiz/Practical exam/Viva/Any other mode of evaluation.

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Program: B. Tech. (Mechatronics Engineering)				**Semester:** VI	
Course/ Module : PLC and Data Acquisition				**Module Code:** BTMA06007	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks- 100 in Question Paper)**
3	2	0	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Digital Electronics (BTMA03009), Microprocessors and Microcontroller (BTMA04011)

Objectives:

1. To introduce fundamentals of Data conversion, PLC and SCADA.
2. To impart knowledge for designing PLC based sequencing applications.

Outcomes:

After completion of the course, students would be able to:

1. Understand the basics of data conversion, data acquisition, PLC and SCADA.
2. Analyze the performance of data converters.
3. Apply PLC for sequence control.
4. Create PLC Ladder logic programs for industrial applications.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	**Data Converters:** Introduction to signal conditioning and its elements, Sampling Theorem, Sampling process, Quantization, Encoding, Aliasing, Sample and hold circuit. DACs – basic DAC technique, weighted resister, R -2R ladder and inverted R -2R ladder types of DACs. ADCs – parallel feedback ADC, dual slope ADC, frequency based ADC and their comparison. DAC/ADC Specifications, Typical ICs for ADC and DAC. Design examples on ADCs and DACs.	**08**
2.	**Data Acquisition Systems (DAS):** Introduction, definition and need for data acquisition systems. Objectives of DAS, Single Channel DAS, Multiplexer – multiplexed channel operation, Multichannel DAS, Interfacing DAS with computer.	**05**
3.	**Programmable Logic Controller (PLC):** Evolution of PLCs, Discrete State Control, Block Diagram of PLC, Classification of PLCs. Description of PLC components: Power Supply, Input and Output Modules , Discrete Input and Output Modules, Analog Input and output Modules, Programming Devices, CPU, I/O module specifications. Typical PLC specifications. Different Addressing modes.	**08**
4.	**PLC Programming:** Memory Organization, Program Files, Data Files, Program Scan Cycle. Types of programming languages used in PLCs: Ladder logic, Functional	**10**

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	block diagram, Sequential flow chart, Instruction List, Structured Text. Rules for ladder logic Programming, Relay Logic Instructions, Latching, Interlocking, Triggers, Logic gates programming in PLC. Timer Instructions: On Delay, Off Delay and Pulse Timers. Counter Instructions: Up counter and Down Counter. Data manipulation instructions, Mathematical instructions, Sequence and Shift register instructions. Analog Module programming.	
5.	**Application Development:** Interfacing of various inputs & outputs to PLC- Electromagnetic Control Relays, Contactors, Motor Starters, Manually operated switches, Mechanically operated switches, Proximity sensors, Encoders, Decoders. Interfacing Remote I/O s with PLC. Design of Tank level control System, Sequential switching of motors, Motor starters, Temperature control, Conveyor belt control, Pneumatic Cylinder control, Automatic Bottle filler. Industrial case studies.	**08**
6.	**Supervisory Control and Data Acquisition (SCADA)**: Introduction to supervisory control, Need of SCADA, Architecture of SCADA. Components of SCADA: MTU, RTU and HMI. Wireless SCADA, Interfacing of SCADA with PLC.	**06**
	Total	**45**

Text Books:

1. Curtis D. Johnson, "Process control Instrumentation Technology", *Prentice Hall*, 8th Edition, June 2005.
2. M.Mitra and S.Gupta, "Programmable logic controllers and Industrial Automation: An Introduction", *Penram International Publishing (India) Pvt. Ltd., 2nd Edition, 2017.*

Reference Books:

1. Petreuzeulla, "Programmable Controllers", *Tata McGraw Hill publication*, 2nd Edition, 2005.
2. G. B. Clayton, "Data Converters", *Palgrave Macmillan Press*, 4th Edition, 2012.

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

Term work should consist of the following:

1. Minimum Ten experiments based on the above syllabus.
2. Industrial Case study on applications of PLC/SCADA.

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Program: B. Tech. (Mechatronics Engineering)				**Semester:** VI	
Course/ Module: Mechanical Measurements and Instrumentation				**Module Code:** BTMA06008	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks- 100 in Question Paper)**
3	2	0	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Basic Electrical Engineering (BTMA01002), Physics (BTMA01003), Digital Electronics (BTMA03009)

Objectives:

1. To develop basic skills required for measurements of mechanical and process parameters.
2. To impart knowledge about applications and working of various metrological instruments.
3. To study different types of sensors and transducers used in industrial applications.

Outcomes:

After completion of the course, students would be able to:

1. Understand the significance of calibration, specifications and characteristics of different measuring instruments.
2. Analyze the impact of factors like surface finish on performance of machines.
3. Select and Apply sensors and transducers for various physical parameters.
4. Analyze the performance of different bridge circuits for measurement of Resistance, Inductance and Capacitance.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	**Introduction to Metrology and measurement system:** Definition and concept of metrology, standards of measurements, methods of measurement. Configuration of Generalized measurement system. Performance characteristics of measuring instruments, Static characteristics- Error, Accuracy, Precision, Span, Range, Sensitivity, Linearity, Reliability and Resolution. Dynamic characteristics- Dynamic error, Speed of response, Fidelity and Lag.	**05**
2.	**Linear Measurements:** Line and end standards, Wavelength standards, slip gauges, design and manufacturing of gauges. **Comparators:** Types, construction and working of Mechanical, Optical, Electrical, Pneumatic Comparators. **Interferometry:** Basic principles, source of light, Optical flats, Fringe pattern and their interpretation	**07**
3.	**Angular Measurement:** Angle standards, sine bar, angle gauges, autocollimator, angle Dekker, optical square, taper measurement, universal bevel protractor **Surface finish Measurement:** Surface texture, assessment of surface roughness, Tomlinson surface meter, and other surface measuring devices.	**05**
4.	**Modern Optical Measurement and Metrology:** Tool Maker's Microscope, Profile Projector, Optical Square. Basics of Optical Interference and Interferometry, Optoelectronic measurements.	**05**

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5.	**Sensors and Transducers:** Principles, Classification and applications. Transducer Selection Criteria for Mechatronics applications. **Pressure Transducers:** Bellows, Diaphragm, Bourdon tubes, Pirani Gauge, Ionization Gauge, Piezoelectric transducer and Strain Gauge. **Flow Transducers:** Orifice Plate, Pitot tube, Ventury tube, Rotameter, Ultrasonic Flow meter, Electromagnetic flow meter. **Temperature Transducers:** RTD, Thermistor, Thermocouple, Pyrometers. **Displacement/Position Transducers:** LVDT, Hall effect transducers, Optical encoders. Resonant Sensor, Optical Fiber based sensor, Grating Leakage.	**10**
6.	**Proximity Sensors:** Basic Principle, Construction, Working and applications of Inductive, Capacitive, Ultrasonic, Magnetic and Photoelectric proximity sensors. Modes of operation of Photoelectric proximity sensors. Performance Comparison and Specifications of different Proximity sensors.	**06**
7.	**Measurement of R, L, C:** Measurement of Resistance, low, medium and high. Kelvin's double bridge, Wheatstone's bridge and Megger. AC bridge circuits for measurement of inductance and capacitance, Maxwell's, Hay's, Schering's and Wein bridge.	**07**
	Total	**45**

Text Books:

1. Nakra and Chowdhury, "Measurement and Control", 3rd Edition, *Tata McGraw Hill*, 2009.
2. H.S. Kalsi," Electronic Instrumentation", *Tata McGraw Hill*, 3rd Edition, 2010.
3. R. K. Jain, "Engineering Metrology", *Khanna Publishers*, 2009.

Reference Books:

1. A. K. Sawhney , "Electrical and Electronic Measurements and Instrumentation", *Dhanpat Rai and Co*.,2012
2. E.O. Doebelin and D. N. Manik, "Doebelin's Measurement Systems", 6" Edition, *McGraw Hill*, 2010.

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

Term work should consist of the following:

1. Minimum Ten experiments based on the above syllabus.
2. Industrial Case study on applications of sensors and transducers.

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Signature

(Prepared by Concerned Faculty/HOD)

Program: B. Tech. (Mechatronics Engineering)				**Semester:** VI	
Course/Module: Professional Ethics and Legal Aspects				**Module Code:** BTMA06009	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks – 50)**	**Term End Examinations (TEE) (Marks- 100 in Question Paper)**
2	0	0	2	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Constitution of India (BTMA01005)

Objectives:

1. To familiarize with basic concepts of the laws governing corporations
2. To provide knowledge of recent developments in Law at the national level
3. To facilitate social and legal awareness from legal perspective

Outcomes:

After completion of the course, students would be able to:

1. Knowledge about the basic concepts of the important business laws
2. Application and interpretation of the business and labour laws in the actual business environment

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1	**<u>Indian Contract Act, 1872</u>** • Introduction to Concepts, Major Definitions under the Act • Stages to formation of a Contract • Essential Elements- o Offer & Acceptance (Essentials) o Capacity of parties (Minors, Unsound Mind, Disqualified by Law) o Free Consent (Vitiating Elements & Effects- Coercion, Undue Influence, Fraud, Misrepresentation, Mistake) o Lawful Consideration & Lawful Object o Possibility to Perform (Doctrine of Frustration) o Agreement Expressly Declared Void • Types-Valid, Void & Voidable Agreements • Performance & Discharge of Contract; • Remedies for Breach of Contract • Special Contracts: o Indemnity & Guarantee o Bailment & Pledge o Contract of Agency	03

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2	**Sale of Goods Act, 1979** • Concept of Sale as a Contract • Essentials of contract of sale & it's conditions • The Rule of Caveat Emptor and the Exceptions • Conditions & Warranties including implied Conditions & Warranties • Rules of Delivery, Unpaid Seller & his rights • Suits for Breach of contract	02
3	**Companies Act, 2013** • Introduction to Act • Administration of Company Law (NCLT/NCLAT) • Types of companies • Characteristics of a company • Essential Documents and their clause: Memorandum of Association, Articles of Association, Certificate of Incorporation • Management: Classification of directors, Key managerial personnel, Types of meetings & resolutions • Lifting of the Corporate Veil • Concept and modes of Winding Up a company	03
4	**Partnership Laws** A) The Partnership Act, 1932 • Nature and Characteristics of Partnership • Types of Partners • Rights and Duties of Partners • Incoming and outgoing Partners • Mode of Dissolution of Partnership B) The Limited Liability Partnership Act, 2008 • Salient Features of LLP • Differences between LLP and Partnership, LLP and Company • LLP Agreement • Partners and Designated Partners • Partners and their Relationship	03
5	**Industrial Relations** • The Trade Union Act, 1926 - Emergence of Trade Unions in India and the changing trends in Trade Unionism and their politics • Industrial Disputes Act, 1947 - Industrial Strikes and Employer Lockouts • Managing Industrial conflicts - Trends and Issues in effective Labour Court Administration • Role of Conciliation Officers in the Resolution of Industrial Disputes	03
6	**Intellectual Property Rights** • Introduction and the need for IPR (WIPO, TRIPS) • Trade Marks Act,1999 - Registration of Trademarks; passing off and infringement	02

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	• Indian Copyright Act, 1957 - Registration and infringement of copyright • Patents Act, 1970 - Meaning of patent & Inventions; Opposition proceedings & Grant of Patent • Overview of Trade secrets and Industrial Designs	
7	**Competition Act, 2002** • Objectives of Competition Law • Concept of Appreciable Adverse Effect on Competition (AAEC) • Anti-Competitive Agreements (S.3)- Horizontal Agreements, Vertical Agreements, Cartels, Blanket provision for IPR • Abuse of Dominance (S.4) • Competition Commission of India – Role, Duties, Competition Advocacy • Appellate Tribunal – Role of NCLAT	02
8	**Alternative Dispute Resolution** • The Law and Methods of Alternative Dispute Resolution • Comparative Study of the various forms of ADR • Application of ADR Methods in Different Fields & Areas • Arbitration & Conciliation Act, 1996 & International Developments • Arbitration clauses, Preparation for Arbitration, Conducting an Arbitration, Seat, Venue, Examinations and its various aspects, Evidence	02
9	**Universal Ethics** • Nature and Essence of Ethics • Role of ethics in Governance • Business Ethics Concepts • Professional ethics	02
10	**Understanding Professional Ethics** • Characteristics of ethical organizations • Causes of unethical behaviour • Benefits of ethical behaviour	02
11	**Applied Ethics: Unethical Practices in Businesses** • Bribery, Conflict of interest and Anti-corruption behaviour • Insider-Trading; meaning and legal provisions • Sexual harassment: The Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Act, 2013	03
12	**Applied Ethics: Combating Unethical Practices in Businesses** • Whistleblowing: Concept and Mechanism • Socially responsible leadership and Corporate Social Responsibility's role in corporate governance • Alternative Dispute Resolution as a tool to overcome unethical practices	03
	Total	**30**

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Text Books:

1. Pathak A, 2013, *Legal Aspects of Business*, 6th Edition, McGraw Hill
2. P Narayanan, 2009, *Intellectual Property Law; 3rd Edition*, Eastern Book Company

Reference Books:

1. Mahesh Tandon, (6th Edition), *Company Law*
2. K R Bulchandani, (2009), *Business Law*, Himalaya Publications
3. H M Jhala, (2007), *Intellectual Property and Competition Law in India;* N M Tripathi P. Ltd.
4. Lucjan Klimsza, (1st Edition), *Business Ethics – Introduction to Ethics of Value*; ISBN: 978-87-403-0690-3
5. Padhi, P.K. (2012), Labor and Industrial Laws, PHI
6. Venkatratnam, C.S. (2004). Industrial Relations, OUP.

Internet References:

1. www.mahalibrary.com
2. www.alllaw.com
3. www.findlaw.com
4. www.justice.com
5. www.legalpundits.com
6. www.indlaw.com
7. www.maupatra.com

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	Marks
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

Term work should consist of the following:

- Class Test/ Assignment/Case Studies/Projects/ Presentations

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Program : B. Tech. (Mechatronics Engineering)				**Semester :** VI	
Course/Module : Research Methodology				**Module Code :** BTMA06010	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks - --- in Question Paper)**
1	2	0	2	Marks Scaled to 50	----

Pre-requisite: ---

Objectives:

1. To familiarize students regarding industrial research projects and methodology.
2. To understand the approaches to do research in the mechatronics domain.

Outcomes:

After completion of the course, students would be able to:

1. Produce a review report related to the research conducted
2. Identify and use print and electronic library resources effectively and appropriately
3. Adhere to ethical guidelines for writing reports and collecting information
4. Create a research proposal based on the review findings

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	**Definition and Characteristics of research:** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Objective of research. Various functions that describe characteristics of research such as systematic, valid, verifiable, empirical and critical approach.	**06**
2.	**Types of research:** Pure and applied research. Descriptive and explanatory research. Qualitative and quantitative approaches. Formulating the Research Problem, Literature Review, Developing the objectives, Preparing the research design including sample Design, Sample size.	**06**
3.	- Identify and use print and electronic library resources effectively and appropriately - Literature search and review	**06**
4.	- Referencing style, plagiarism basics and checks - Writing a review report	**04**
5.	- Drafting a research proposal	**04**
6.	**Outcome of Research:** Validity of research outcomes, suggestions and recommendations. Identifying future scope.	**04**
	Total	**30**

Text Books:

1. Kumar, Ranjit, 2005, *Research Methodology-A Step-by-Step Guide for Beginners*, (2nd.ed), Singapore, Pearson Education.

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2. Kothari, C.R.,1985, *Research Methodology-Methods and Techniques,* New Delhi, Wiley

Reference books:

1. Dawson, Catherine, 2002, *Practical Research Methods,* New Delhi, UBS Publishers' Distributors. Eastern Limited.

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**--**
Term Work Marks	**50**
Total Marks :	**50**

Details of Term work:

Term work should consist of the following:

1. Assignment/Presentation/Report Writing/Case Study

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Program : B. Tech. (Mechatronics Engineering)				**Semester :** VI	
Course/Module: (Professional Elective Course-3) CAD/CAM/CIM				**Module Code :** BTMA06011	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks - 100 in Question Paper)**
3	2	0	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Engineering Graphics & Design(BTMA01004), Manufacturing Processes (BTMA03011)

Objectives:

1. To introduce the basics of backend of drafting packages.
2. To give hands on experience on the 3D Modeling software.
3. To impart knowledge of NC/CNC machines and programming of CNC using machine codes.
4. To provide concepts of GT, CAPP, CAQC and CIM.

Outcomes:

After completion of the course, students would be able to:

1. Create accurate and precise geometry of complex engineering systems and use the geometric models in different engineering applications.
2. Apply the concepts of machining for the purpose of selection of machining parameters and cutting tools for CNC milling and turning.
3. Understand concepts of different CAD/CAM/CIM systems and different data management systems.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	**Introduction and Elements of interactive computer graphics:** The design process, the role of modeling and communication. Modeling using CAD, product life cycle and Computer-Aided Design (CAD)/ Computer-Aided Manufacturing(CAM), Concurrent engineering in product design and development, Collaborative Engineering, Computers for design process, CAD System Architecture-Software and Hardware.	**08**
2.	**Techniques for geometric modeling :** Graphic standards, The parametric representation of geometry-Bezier curves, Cubic spline curve, B-Spline curve, parametric representation of line, circle, ellipse and parabola, Constructive solid geometry (CSG), Boundary representation (B-rep), Wire Frame modeling, Solid modeling, Surface modeling, feature based modeling, Assembly Modeling- Different approaches of creating an assembly, Parent child relationship.	**06**
3.	**Transformation, Manipulation and Data Storage:** 2D and 3D Transformations (Translation, Rotation, Scaling and Magnification), Concatenations, Matrix representation, Problems on Transformations. Object transformation, mirror transformation, Bill of Materials from	**08**

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	attribute data, Engineering data management system, relational data base for design, object oriental database, Design Information Systems.	
4.	**NC and CNC technology**: Introduction, basic components of Numeric Control (NC) system, NC procedure, NC coordinate systems, NC motion control systems, Various actuation systems and feedback devices like encoder, tachogenerator, etc. Applications, Advantages and Disadvantages of NC machines. Constructional details of Computer Numeric Control (CNC) machines, CNC programming concepts, Manual part programming methods, Various G and M codes, Absolute and incremental system, Tool length and diameter compensation, Programming of turning and milling, Use of canned cycles, subroutines. Flexible Manufacturing Systems (FMS), Machining Centers and its types, Automated Material Handling and Storage Systems like Robots, Automated Guided Vehicles (AGV) and Automated Storage and Retrieval Systems (AS/RS)	**10**
5.	**Group Technology, CAPP and CAQC:** Introduction to Group Technology (GT), Part families, Part Classification and Coding, GT Machines cells, Benefits of GT. Introduction to Computer Aided Process Planning (CAPP), Retrieval type Process Planning Systems, Generative type Process Planning Systems, Benefits of CAPP, PFA, Similarity coefficient matrix. Introduction to Computer Aided Quality Control (CAQC), Computers in QC, Contact Inspection Methods, Non-Contact Inspection Methods, Integration of CAQC with CAD/CAM	**07**
6.	**Computer Integrated Manufacturing and Technology driven practices:** Introduction, Evolution, Objectives, CIM Hardware and software, CIM Benefits, Nature and role of elements of CIM, Identifying CIM needs, Data base requirements of CIM, Role of CAD/CAM in CIM, Obstacles to Computer Integrated Manufacturing, CIM wheel, Design for Manufacturing (DFM) and Design for Assembly (DFA). Introduction to Rapid Prototyping, Virtual Prototyping. Introduction to Smart Manufacturing and Smart Design Concept.	**06**
	Total	**45**

Text Books:

1. Mikell P. Groover and Emory W. Zimmers, Jr.,"CAD/CAM Computer Aided and Manufacturing" Eastern Economy Edition, *PHI*.
2. Ibrahim Zeid, R. Sivasubramanian (2009), "CAD/ CAM, Theory and Practice" *Tata McGraw Hill Publications*.

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Reference books:

1. P. N. Rao (2010), "CAD/CAM Principles and Applications" Tata McGraw *Hill Publications*.
2. P. Radhakrishan, S. Subramanyan, V. Raju (2004), "CAD/CAM/CIM", *New Age International Publishers.*

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

Term work should consist of the following:

1. Assignments based on syllabus (Min. 3).
2. Laboratory assignments on solid modeling/assembly using any 3D modeling software (Solid Works/Catia/Pro-E). (Min. 6)
3. Part programming and part fabrication on CNC trainer (Turning/Milling). (Min. 2)
4. Viva Voice, Quiz based on syllabus/laboratory examination based on solid modeling.

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Program: B. Tech. (Mechatronics Engineering)				**Semester:** VI	
Course/Module: (Professional Elective Course-3) Modeling and Simulation				**Module Code:** BTMA06012	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks- 100 in Question Paper)**
3	2	0	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Programming for Problem Solving (BTMA02009)

Objectives:

1. To provide an exposure on how to simulate a system.

Outcomes:

After completion of the course, students would be able to:

1. Evaluate decisions by optimization using simulation techniques.
2. Select the right method of simulation as per the system.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	System – ways to analyze the system – Model - types of models – Simulation – Definition – Types of simulation models – steps involved in simulation – Advantages & Disadvantages. Monte Carlo Simulation. Parameter estimation – estimator – properties – estimate – point estimate – confidence interval estimates – independent – dependent – hypothesis – types of hypothesis- steps – types 1& 2 errors – Framing – strong law of large numbers.	**10**
2.	Building of Simulation model – validation – verification – credibility – their timing – principles of valid simulation Modeling – Techniques for verification – statistical procedures for developing credible model. Modeling of stochastic input elements – importance – various procedures – theoretical distribution – continuous – discrete – their suitability in modeling.	**08**
3.	Generation of random variates – factors for selection – methods – inverse transform – composition – convolution – acceptance – rejection – generation of random variables – exponential – uniform – weibull – normal Bernoulli – Binomial – uniform – poisson. Simulation languages – comparison of simulation languages with general purpose languages – Simulation languages vs Simulators – software features – statistical capabilities – G P S S – SIMAN- SIMSCRIPT –Simulation of M/M/1 queue – comparison of simulation languages.	**09**
4.	Output data analysis – Types of Simulation w.r.t output data analysis – warmup period- Welch algorithm – Approaches for Steady – State Analysis – replication – Batch means methods – comparisons	**08**

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5.	Applications of Simulation – flow shop system – job shop system – M/M/1 queues with infinite and finite capacities – Simple fixed period inventory system – New boy paper problem	**10**
	Total	**45**

Text Books:

1. Law & Kelton (2000) ,"Simulation Modeling and Analysis", 3rd Edition., McGraw-Hill Inc.

Reference Books:

1. Carrie A. & Wiley (1990), Simulation of Manufacturing Systems, NY, 1990.

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

Term work should consist of the following:

1. Assignments based on the above syllabus (Min. 3).
2. Viva Voce, Quiz based on syllabus/laboratory examination
3. Two term test papers.
4. Project based on simulation.

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Program: B. Tech. (Mechatronics Engineering)				**Semester:** VI	
Course/ Module: (Professional Elective Course-3) Dynamic System Modeling and Analysis				**Module Code:** BTMA06013	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks- 100 in Question Paper)**
3	2	0	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Engineering Mathematics - I, II and III (BTAB01001, BTAB02001 and BTMA03001), Thermodynamics and Heat Transfer (BTMA05012)

Objectives:

1. To understand physical systems e.g. mechanical, electrical, thermal and fluid systems and converting them to mathematical models.
2. To understand the mathematical Modeling and response analysis of dynamic systems that is required in Mechanical engineering.
3. To learn the use of any mathematical software.

Outcomes:

After completion of the course, students would be able to:

1. Design the mathematical models of the physical systems.
2. Analyse the response of the systems and also modify the systems as per the requirements using mathematical software.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	**Introduction to system dynamics:** Introduction, Mathematical Modeling of Dynamic System, Analysis and Design of Dynamic Systems.	**05**
2.	**The Laplace transform:** Introduction, Complex Numbers, Complex Variables, and Complex Functions, Laplace Transformation, Inverse Laplace Transformation, Solving Linear, Time-Invariant Differential Equations, Example Problems and Solutions, Problems.	**05**
3.	**Mechanical systems:** Introduction, Mechanical Elements, Mathematical modeling of simple Mechanical systems, Work, Energy, and Power, Example Problems and Solutions, Problems.	**06**
4.	**Transfer-Function approach to modeling dynamic system:** Introduction, Block Diagrams, Partial-Fraction Expansion with MATLAB, Transient-Response Analysis with MATLAB, Example Problems and Solutions, Problems.	**08**
5.	**State-Space approach to modeling dynamic system:** Introduction, Transient-Response Analysis OF Systems in State-Space Form with MATLAB, State-Space Modeling of System with Input Derivatives, Transformation of Mathematical Models with MATLAB, Example Problems and Solutions, Problems.	**07**

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6.	**Electrical systems and electromechanical systems:** Introduction, Fundamentals of Electrical Circuits, Mathematical Modeling of Electrical Systems, Analogous Systems, Mathematical Modeling of Electromechanical Systems, Mathematical Modeling of Operational-Amplifier Systems	**08**
7.	**Fluid systems and thermal systems:** Introduction, Mathematical Modeling of Liquid-Level Systems, Mathematical Modeling of Pneumatic Systems, Linearization of Nonlinear Systems, Mathematical Modeling of Hydraulic Systems, Mathematical Modeling of Thermal Systems	**06**
	Total	**45**

Text Books:

1. Oghata (2007), "System Dynamics" *Pearson Publications*.
2. Norman Nise (2008), "Control System Engineering" *Wiley*.

Reference Books:

1. Close, Fredrik (2001), "Modeling and Analysis of Dynamic System" *Wiley*.
2. Narsico, George Julius (2005), "Modeling and Control of Dynamic System" *Thomson*.

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

Term work should consist of the following:

1. Assignments based on above topics (Min. 3).
2. Viva Voce Examination
3. Two term test papers.
4. Project based on simulation.

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Program: B. Tech. (Mechatronics Engineering)				**Semester :** VI	
Course/Module: (Professional Elective Course-4) Automobile Engineering				**Module Code :** BTMA06014	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks - 100 in Question Paper)**
3	2	0	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Theory of Machines (BTMA05008)

Objectives:

1. To impart the knowledge of the basics of the automobiles.
2. To introduce the different automobile systems like suspension, axles and steering and transmission systems in the Automobiles.

Outcomes:

After completion of the course, students would be able to:

1. Understand the types of engines used in automobile and their characteristics, selections of suitable rear axle, gear etc.
2. Analyze the chassis layout, steering geometry, types of suspensions, and clutch and gear mechanism of vehicle.
3. Understand the clutch and braking mechanisms.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	**Vehicle Performance:** Types of engines used in automobiles, their characteristics and selections, resistance to motion of vehicle, air, rolling and gradient resistances, power requirement for acceleration and tradability, selection of suitable rear axle and gear ratios.	**06**
2.	**Chassis:** Chassis layout, power plant location, types of automobiles, weight distribution stability, type of frame, materials.	**04**
3.	**Steering:** Steering geometry, wheel alignment and wheel balancing, center point Steering, Ackerman and Davis steering, cornering force slip angle, scrub radius, steering conventional layout of steering system. Steering systems for independent suspension, wheel wobble and shimmy, power steering. **Axle:** Axle material, load and stresses on front axle design, steering heads, axle bearing wheel alignment, differential and their types, rear axle arrangements, two speed rear axle, single, double and triple reduction rear axles. **Tires:** Function, construction, types of tires, tubeless tire.	**12**
4.	**Suspension System:** types of suspensions, materials, shackles and mountings, types of springs, shock absorbers, sprung weight and un sprung weight, conventional suspension system, independent suspension, air suspension, hydra-gas suspension, rubber suspension, interconnected suspension, self-leveling suspension	**08**

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5.	**Drive mechanisms:** Torque reaction, driving thrust, propeller shaft, universal joints, and constant velocity universal joints. Differential, action of differential, constructional details, types of rear axles, materials, bearing loads, double reduction and two speed axle, front wheel drive, all-wheel drive, introduction to continuous variable transmission (CVT).	**07**
6.	**Clutch and braking mechanisms:** **Clutch:** Clutch mechanism-wet/dry clutch- constant pressure, constant wear type, back up plate, cone clutch, centrifugal clutch, multi-plate clutch, clutch materials, influence of temperature on the performance, torque limiter. Numerical Examples. **Braking Systems**: types and construction, mechanical, hydraulic system, diagonal braking system, antilock braking system. Numerical Examples.	**08**
	Total	**45**

Text Books:

1. K. K. Jain and Asthana (2002), "Automobile Engineering", *TTI Publications*.
2. R.K. Rajput (2007), "A Text Book of Automobile Engineering", *Laxmi Publications*.
3. S. Kripal (2009), "Automobile Engineering Vol I", *New Chand Jain*.

Reference Books:

1. G. Genta, Morello (2009), "The Automotive Chassis: System Design", *Springer*.
2. Society of Automotive Engineering (1997), "Automotive Engineering".
3. D. Crolla (2009), "Automotive Engineering: Powertrain, Chassis System, Vehicle, Body", *Butterworth- Heinemann*.

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

Term work should consist of the following:

1. One assignment from each unit.
2. Experiments (any 5) based on the above syllabus
3. Study of Engines, systems and mechanisms of vehicles with sketches and write ups.
4. Viva Voce /Presentations
5. Two term test papers.

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Program : B. Tech. (Mechatronics Engineering)				**Semester :** VI	
Course/Module: (Professional Elective Course-4) Design of Machine Elements				**Module Code:** BTMA06015	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks- 100 in Question Paper)**
3	2	0	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Engineering Mechanics (BTMA03010), Strength of Materials (BTMA04013)

Objectives:

1. To understand the impact of different types of stresses on components
2. To introduce the fundamental concepts of design of simple machine parts.

Outcomes:

After completion of the course, students would be able to:

1. Understand the importance of materials in design and select appropriate materials for safe design.
2. Apply the principle and basic procedure of machine components design.
3. Analyze the different types of loads and stresses acting on components.
4. Design of various machine components like shafts, couplings, springs, joints, gears and belts.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	**Stress Analysis:** Design process-Selection of materials-preferred numbers, fits and tolerances, direct, bending and shear stress-combined stresses-eccentric loading on machine members-stress concentration and notch sensitivity.	**09**
2.	**Design of Shafts, Coupling and Springs:** Design of solid shafts based on strength, rigidity. Design of muff coupling and rigid flange coupling, Design of coil springs.	**12**
3.	**Design of Joints:** Design of bolted joints including axial and tensile loading, Knuckle joints, Cotter joints, Bolt of uniform strength, Thread locking devices, Design of riveted joints for structures.	**10**
4.	**Design of Gears:** Design of spur gear based on contact stress and beam strength and based on Lewis and Buckingham equations.	**08**
5.	**Design of Flexible Drives:** Design of flat belt and V-belt drives.	**06**
	Total	**45**

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Text Books:

1. J. F. Shigley (2008), "Mechanical Engineering Design", 8th Edition, Tata McGraw Hill
2. V. B. Bhandari (2010), "Design of Machine Elements", 3rd Edition, Tata McGraw Hill

Reference Books:

1. Hall, Holowenko, Laughen, (2008) "Machine Design" Schaum's outline series Tata McGraw Hill Publication.
2. M. F. Spotts (2004), "Design of Machine Elements", 8th Edition, Pearson Publication.
3. PSG design data book

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	Marks
Test Marks	20
Term Work Marks	30
Total Marks:	50

Details of Term work:

Term work should consist of the following:

1. Design project on Assemblies covering above syllabus. The design project shall consist of sheet involving assembly-drawing with a part list and overall dimensions and drawings of individual components. A design report giving all necessary calculations of the design of components and assembly should be submitted in a separate file. Design data book shall be used wherever necessary for selection of standard components.
2. Assignments based on the above syllabus (Min. 3). Computational platform Octave/Scilab 6.0.1 will be used extensively for simulation
3. Viva Voice or Multiple Choice Questions (MCQ) Examination.

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Program: B. Tech. (Mechatronics Engineering)				**Semester:** VI	
Course/Module: (Professional Elective Course-4) Additive Manufacturing				**Module Code:** BTMA06016	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks - 50)**	**Term End Examinations (TEE) (Marks- 100 in Question Paper)**
3	2	0	4	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Manufacturing Processes(BTMA03011), Materials Engineering (BTMA5013)

Objectives:

1. Acquire introductory knowledge of Additive Manufacturing (AM) and its capabilities in the modern digital manufacturing industry.
2. To get acquainted with the operating principles and applications of most prominent technologies in the field of Additive Manufacturing.
3. Explore the Design for Additive Manufacturing capabilities of each AM process and to identify and create complex and novel designs.

Outcomes:

After completion of the course, students would be able to:

1. Understand the fundamental principles of various Additive Manufacturing (AM) technologies, material requirements and cost considerations with regards to each AM process.
2. Identify critical areas where AM can be applied to create value for the entire product life-cycle.
3. Select the right AM process for a given application.
4. Develop an enterprising perspective concerning the application of AM in the design of a product, either entirely or partly.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	**Introduction to Additive Manufacturing:** Introduction to AM, history of AM, definition, distinction between AM, CNC & other digital manufacturing techniques, reasons to use AM, classifications of AM processes, design for Additive Manufacturing (DfAM), AM industry: present and future, AM process chain, CAD and file formats for AM. Introduction to Metal Additive Manufacturing. Laser Cutting vs Water jet cutting.	**04**
2.	**Extrusion based AM processes:** Fused deposition Modeling(FDM), history of FDM, material requirements, workflow: material loading, liquefaction, bonding, solidification, support generation, nozzle dynamics, applications, benefits and limitations, post-processing, material characterization, extrusion of: ceramics, metals, biomaterials, composites, non-planer systems, contour crafting, concrete printing.	**05**
3.	**Vat Polymerization AM process:** Stereolithography apparatus(SLA), history of SLA, material requirements, workflow: SLA chemistry, reaction mechanism,	**05**

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	scan patterns, applications, benefits and limitations, other liquid polymer-based systems: Solid Ground Curing (SGC), Microstreolithography, Digital Light Processing (DLP), Continuous Liquid Interface Production (CLIP), Large-Scale Rapid Liquid Printing.	
4.	**Sheet Lamination AM Processes:** Laminated Object Manufacturing (LOM), LOM of paper, polymer and composite sheets, LOM mechanism: gluing, adhesive bonding, bond then from, from then bond, thermal bonding, sheet metal clamping, Ultrasonic Additive Manufacturing(UAM), ultrasonic welding fundamentals, UAM process parameters, material characterization.	**04**
5.	**Powder Bed Fusion AM Process:** Selective Laser Sintering (SLS): process workflow and material requirements, powder production methods, powder fusion mechanism, polymer ageing and recycling, High Speed Sintering(HSS), Multi-Jet Fusion(MJF), polymer powder characterization and selection, Selective Laser Melting (SLM): process workflow and material requirements, powder melting mechanism, melt pool dynamics, laser scan patterns, post-processing, powder production, handling and recycling, Electron Beam Melting (EBM) Process.	**11**
6.	**Binder Jetting (BJ) & Material Jetting AM Process:** workflow, thermal and piezoelectric inkjet, material requirements, material jetting fluid mechanics, drop-on-demand and continuous methods of MJ, material jetting of metals, ceramics, nanomaterial, BJ AM Process: process workflow, material requirements, powder characterization for BJ process, binder-powder interaction, binder properties.	**06**
7.	**Directed Energy Deposition (DED) Processes:** Process workflow, materials feeding for DED: powder (Laser Engineered Net Shaping) & wire, process parameters and optimization, Electron Beam Additive Manufacturing (EBAM) plasma-based DED, Cold Spray.	**04**
8.	**Design for Additive Manufacturing (DfAM):** Key process-specific DfAM guidelines, AM file formats (STL, 3MF, AMF, PLY, VRML, LEO): processing, conversion and repair algorithms, tool path generation, topology optimization, generative design, slicing and support generation.	**06**
	Total	**45**

Text Books:

1. Gibson I, Rosen D W, Stucker B (2015), "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", *Springer.*

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Reference Books:

1. Yang, L., Hsu, K., Baughman, B., Godfrey, D., Medina, F., Menon, M., & Wiener, S. (2017). "Additive manufacturing of metals: the technology, materials, design and production", *Springer.*
2. Gebhardt, Andreas. (2011). "Understanding additive manufacturing." *Hanser Publication*
3. Bártolo, P. J. (Ed.). (2011). Stereolithography: materials, processes and applications. *Springer Science & Business Media*.

Any other information:

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	Marks
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

Term work should consist of the following:

1. Mini Project: Teams with 3~4 members will work on a small project related to AM OR Case study
2. Experiments (min 8) based on the above syllabus
3. Industrial visit and report

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SVKM's Narsee Monjee Institute of Management Studies
Mukesh Patel School of Technology Management and Engineering

Program: B. Tech. (Mechatronics Engineering)				**Semester : VII**	
Course : Mechatronics System Design				**Code:** BTMA07001	
Teaching Scheme				**Evaluation Scheme**	
Lecture Hours per week	**Practical Hours per week**	**Tutorial Hours per week**	**Credit**	**Internal Continuous Assessment (ICA) As per Institute Norms (Marks – 50)**	**Theory (3 Hrs., 70 Marks)**
3	2	0	4	Scaled to 30 marks	Scaled to 70 marks

Pre-requisite: Basic electronics (BTAB02003), Instrumentation (BTMA05003) and Basic Control Systems (BTMA05006), Microprocessors and Interfacing (BTMA04006)

Objectives:

1. To develop skills related to Mechatronic systems.
2. To understand low cost production of sensor and actuator system and biomedical systems
3. To expose students to sensing and actuation principles, Microprocessors, circuit and system issues, modeling, packaging, calibration and testing.

Outcomes: After successfully completion of this course, students should be able to

1. Select appropriate sensors/ transducers for fluid power control.
2. Know the control system theory and microprocessor based applications.
3. Implement and control the model of a mechanical system plant.

Detailed Syllabus:

Unit	**Description**	**Duration (Hours)**
1.	**Introduction** Definition and Introduction to Mechatronic Systems, Measurement Systems, Control Systems, and Microprocessor based controllers and Applications.	**06**

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2.	**Study of Actuation Systems** Pneumatic and Hydraulic Systems, Mechanical Actuation System, Electrical Actuation Systems.	**06**
3.	**Smart Sensors** Principles, design, working and selection of sensors for Mechatronic system design, Sensor data acquirement. Basic principles of the acquirement and transmission of the data (signals and buses), Data processing, Pattern recognition and classification, Intelligent sensors, Definitions, examples, Complex sensors, biometric sensors (fingerprint scanners, retina scanners, etc.)	**08**
4.	**Intelligent Sensors** Soft-Computing (fuzzy logic, neural networks, agents), use in the intelligent sensors, Sensor networks. Centralized and decentralized system of the measurement chains. Communication (IEEE 1415), distributed systems, Future of the intelligent sensors, trends (Nano sensors, biosensors).	**04**
5.	**Closed Loop controllers:** Continuous and discrete processes control modes, two step mode, proportional mode, derivative control, integral control, PID controller, digital controllers, control system performance, controller tuning.	**06**
6.	**Hardware components and Real Time Interfacing for Mechatronics** Transducer signal conditioning and devices for data conversion, programmable Controllers, Introduction to Real Time, Elements of Data Acquisition and Control system, Overview of the I/O processes, Installation of the I/O card and installation of the application software.	**08**
7.	**Modeling for Mechatronic Systems Design** Introduction, System, Mechanical System, Electrical System, Fluid system, Thermal System, Engineering system, Translational mechanical system with spring, damper and mass, Rotational mechanical system with spring, damper and mass, Modeling of electric motor, Chamber filled with fluid, Pneumatic actuator.	**07**
	Total	**45 Hours**

Text Books:

1. Devdas Shetty and Richard A. Kolk, Mechatronics System Design, Second Edition,

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Cengage Learning, 2011
2. Ida, N., Sensors, Actuators, and their Interfaces; 2014; Scitech Publishing; ISBN: 978-1-61353-006-1.
3. W. Bolton, Mechatronics, Third Edition, Pearson Education, 2009.

Reference Books:

1. Stephen D. Senturia, Microsystems Design, Kluwer, Boston, 2001 (Classic)
2. Kenneth J. Ayala, "The 8086 microprocessor: programming and interfacing the PC", Cengage Learning, 8th Indian reprint, 2011.
3. Katsuhiko Ogata, Modern Control Engineering, Prentice Hall of India, 5th edition, 2006

Term Work:

1. Minimum two assignments.
2. Minimum ten experiments and tutorials covering the whole syllabus duly recorded and graded.
3. Two term test papers.

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SVKM's Narsee Monjee Institute of Management Studies
Mukesh Patel School of Technology Management and Engineering

Program: B. Tech. (Mechatronics Engineering)				**Semester: VII**	
Course: Industrial Engineering				**Code:** BTMA07002	
Teaching Scheme				**Evaluation Scheme**	
Lecture Hours per week	**Practical Hours per week**	**Tutorial Hours per week**	**Credit**	**Internal Continuous Assessment (ICA) As per Institute Norms (Marks – 50)**	**Theory (3 Hrs., 70 Marks)**
3	0	2	4	Scaled to 30 marks	Scaled to 70 marks

Pre-requisite: Manufacturing Processes (BTMA04005)

Objectives:

- To introduce various approaches to productivity.
- To impart knowledge of work-study techniques for examination of human work.
- To apply ergonomic principles to enable working effectively with minimization of occupational stresses.
- To introduce the concept of value engineering and applications.

Outcomes:

After successful completion of this course, students should be able to

- Calculate the productivity of resources for improvements.
- Improve the methods to measure parameters such as time and magnitude of activities performed.
- Assess the cost effectiveness of each function of the product in terms of usefulness to the customer.

Detailed Syllabus

Unit	Description	Duration (Hours)
1	**Productivity:** Productivity concepts. Analyzing the work content of a job to identify and reduce/eliminate the excess work content. Interdependence between working conditions and productivity. Significance of theory of Scientific Management. Improving Efficiency and Productivity through Work study. Work study components. Relationship between Method Study and Time Study.	**06**
2	**Method Study:** Basic procedure of method study. Factors in selecting a job to a studied. Recording the facts with charts and diagrams. Questioning technique for development of new method. Role of	**08**

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	Management and workers in implementation.	
3	**Facilities & Workplace Design:** Aligning the physical facilities- plant layout, equipment and work flow as per the production processes. Principles of Motion Economy. Standardization of the process.	**05**
4	**Work Measurement**: Significance of work measurement. Techniques of work measurement. Need of work sampling technique. Conducting work sampling study. Analytical estimation of work. Concept of rating factor. Consideration of various allowances. Standard time for work. Predetermined time standards. Use standard data. MOST for work measurement. Use of time standards.	**10**
5	**Ergonomics:** Field of Ergonomics. Physical and cognitive issues of ergonomics. Aims of ergonomics considerations. Working postures of operatives. Design of objects, facilities and environment. Anthropometrical details. Database of human factors. Ergonomic improvement of physical and cognitive issues. Ergonomics principals. Information input and human control of systems. Work space and arrangement. Living environment. Visual displays	**07**
6	**Value Engineering:** Definition of Value Engineering, Uses of Value Engineering, Reasons for unnecessary costs, Difference between Value Engineering and other cost reduction techniques. Case studies	**09**
	Total	**45 Hours**

Text Books:

1. *International Labor Office* (2014), "Introduction to Work Study", Oxford & IBH Publishing Co. Ltd.
2. Ralph Barnes (2002), "Time & Motion study", *Asia Publishing*.

Reference Books:

1. M. S. Sanders & E J McCormick (2002), "Human factors in Engineering & Design", *Tata McGraw Hill*.
2. K. B. Zandin (2003), "Most Work Measurement System".
3. Merton E. Davis, William D. Falcon, Value Analysis (2002), "Value Engineering: The Implications for Managers", *American Management Association*.
4. By Richard J Park (1999), "Value Engineering: A Plan for Invention", *CRC Press*.
5. Otto, K. N. (2008), "Product Design", *Pearson Education*.

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Term work: **1.** Assignment on above syllabus (Min. 3). **2.** Report on Experiments given below and presentation. **3.** Two term test papers.
List of Experiments: **1.** Experiment on rating to understand the concept of Standard Time. **2.** Experiment on appropriate Recording Techniques of Method Study. **3.** Experiment on Layout of Physical facilities (using Flow diagram/ String diagram/ Travel chart or any other work study technique) **4.** Experiment on Designing a Workplace / workstation for any process using principles of Motion Economy. **5.** Study Experiment on Ergonomic assessment of an Industrial product. **6.** At least one Case Study for Value Engineering.

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SVKM's Narsee Monjee Institute of Management Studies
Mukesh Patel School of Technology Management and Engineering

Program:	**B. Tech. (Mechatronics Engineering)**			**Semester : VII**
Course :	Project Phase I			**Code :**BTMA07003
Teaching Scheme				**Evaluation Scheme**
Lecture Hours per week	**Practical Hours per week**	**Tutorial Hours per week**	**Credit**	**Internal Continuous Assessment (ICA) As per Institute Norms (Marks – 100)**
0	8	0	4	Scaled to 100 Marks

Pre-requisite: Core Mechatronics subjects till 3rd year

Objectives:

1. To do literature survey in the topic selected for major project.
2. To explore the feasibility of the project.
3. To design and formulate the work to be carried out in next phase.

Outcomes:

After successful completion of the project phase, the student will be able to

1. Select an appropriate problem statement.
2. Analyse different designing parameters.
3. To design and formulate the work to be carried out in next project phase.

Activities to be done in phase I:

1. The Project group to be formed consisting of not more than 3 students.
2. The Project area and topic is to be selected in consultation with Project Mentors, alternatively students can propose the topics.
3. The Names of the students and the topic of the Project to be submitted in the first week of the semester along with name of the mentor.
4. The first phase of the project will involve Literature Survey, feasibility study, Design and Part Implementation.
5. Student is required to submit a 1-2 pages weekly report on the work done to the mentor. Attendance will be given on the report. There would continuous evaluation based on the weekly report submitted for 50 marks.
6. Report primarily containing Literature Survey, feasibility study, Design and Part Implementation is to be submitted at the end of the Semester. (Spiral Bound Report)
7. Presentation (about 30 minutes) of the work done during the Semester to be evaluated by External Examiner and Project Mentor.

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SVKM's Narsee Monjee Institute of Management Studies
Mukesh Patel School of Technology Management and Engineering

Program: B. Tech. (Mechatronics Engineering)				**Semester : VII**	
Course: (Elective I) - Dynamic System Modeling and Analysis				**Code :** BTMA07004	
Teaching Scheme				**Evaluation Scheme**	
Lecture Hours per week	**Practical Hours per week**	**Tutorial Hours per week**	**Credit**	**Internal Continuous Assessment (ICA) As per Institute Norms (Marks – 50)**	**Theory (3 Hrs., 70 Marks)**
3	0	2	4	Scaled to 30 marks	Scaled to 70 marks

Pre-requisite: Engineering Mathematics - I, II and III (BTAB01001, BTAB02001 and BTMA03001), Thermodynamics and Heat Transfer (BTMA04004)

Objective:

- To understand physical systems e.g. mechanical, electrical, thermal and fluid systems and converting them to mathematical models.
- To understand the mathematical Modeling and response analysis of dynamic systems that is required in Mechanical engineering.
- To learn the use of any mathematical software.

Outcomes:

After successful completion of the course, students should be able to

- Convert the physical systems into mathematical models and will be able to identify the response of the systems and also modify the systems as per the requirements using mathematical software.

Detailed Syllabus

Unit	Description	Duration (Hours)
1	**Introduction to system dynamics:** Introduction, Mathematical Modeling of Dynamic System, Analysis and Design of Dynamic Systems.	05
2	**The Laplace transform:** Introduction, Complex Numbers, Complex Variables, and Complex Functions, Laplace Transformation, Inverse Laplace Transformation, Solving Linear, Time-Invariant Differential Equations, Example Problems and Solutions, Problems.	05
3	**Mechanical systems:** Introduction, Mechanical Elements, Mathematical modeling of simple Mechanical systems, Work, Energy, and Power, Example Problems and Solutions, Problems.	06

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4	**Transfer-Function approach to modelling dynamic system:** Introduction, Block Diagrams, Partial-Fraction Expansion with MATLAB, Transient-Response Analysis with MATLAB, Example Problems and Solutions, Problems.	**08**
5	**State-Space approach to modelling dynamic system:** Introduction, Transient-Response Analysis OF Systems in State-Space Form with MATLAB, State-Space Modelling of System with Input Derivatives, Transformation of Mathematical Models with MATLAB, Example Problems and Solutions, Problems.	**07**
6	**Electrical systems and electromechanical systems:** Introduction, Fundamentals of Electrical Circuits, Mathematical Modelling of Electrical Systems, Analogous Systems, Mathematical Modelling of Electromechanical Systems, Mathematical Modelling of Operational-Amplifier Systems	**08**
7	**Fluid systems and thermal systems:** Introduction, Mathematical Modelling of Liquid-Level Systems, Mathematical Modelling of Pneumatic Systems, Linearization of Nonlinear Systems, Mathematical Modelling of Hydraulic Systems, Mathematical Modelling of Thermal Systems	**06**
	Total	**45 Hours**

Text Books:

1. Oghata (2007), "System Dynamics" *Pearson Publications*.
2. Norman Nise (2008), "Control System Engineering" *Wiley*.

Reference Books:

1. Close, Fredrik (2001), "Modelling and Analysis of Dynamic System" *Wiley*.
2. Narsico, George Julius (2005), "Modelling and Control of Dynamic System" *Thomson*.

Term Work:

1. Five Assignments based on above topics (Min. 3).
2. Viva Voce Examination
3. Two term test papers.

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SVKM's Narsee Monjee Institute of Management Studies
Mukesh Patel School of Technology Management and Engineering

Program: B. Tech. (Mechatronics Engineering)				**Semester : VII**	
Course: (Elective I) - Flexible Manufacturing Systems				**Code:** BTMA07005	
Teaching Scheme				**Evaluation Scheme**	
Lecture Hours per week	**Practical Hours per week**	**Tutorial Hours per week**	**Credit**	**Internal Continuous Assessment (ICA) As per Institute Norms (Marks – 50)**	**Theory (3 Hrs., 70 Marks)**
3	0	2	4	Scaled to 30 marks	Scaled to 70marks

Pre-requisite: Manufacturing Process (BTMA04005)

Objectives:

- To introduce the basic concepts of flexible manufacturing system (FMS) like material handling, loading, scheduling, storage etc.
- To impart the knowledge of modelling and Analysis in FMS.

Outcomes:

After successful completion of this course students will be able to

- Understand the development & Implementation of an FMS with its hardware and software development.
- Analyze the importance of material handling, loading, scheduling, storage etc. with FMS.
- Compare the different FMS using GT, JIT through typical case studies.

Detailed Syllabus

Unit	Description	Duration (Hours)
1	**Flexible Manufacturing System (FMS - an Overview:** Definition of an FMS – Types & configurations concepts – Types of flexibility & performance measures. Function of FMS host computer – FMS host and area controller function distribution.	04
2	**Development & Implementation of an FMS:** Planning phase - Integration- System configuration - FMS layouts - Simulation -FMS Project development steps. Project management - Equipment development-Host system development - planning-Hardware & Software development.	07
3	**Automated Material Handling & Storage:** Functions - Types - Analysis of material handling equipment's, Design of Conveyor & AGV systems. Problems.	05

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4	**Automated Storages:** Storage system performance - AS/RS - Carousel storage system - WIP storage system - interfacing handling storage with manufacturing, modelling and analysis of FMS using Queuing Simulation and Heuristics	**07**
5	**Concepts of Distributed Numerical Control:** DNC system - Communication between DNC computer & machine control unit - Hierarchical processing of date in DNC system - Features of DNC systems.	**06**
6	**Scheduling & Loading of FMS:** Introduction - Scheduling of operations on a single machine - two machine flows hop scheduling - two machine job shop scheduling, three machine flow shop scheduling - scheduling 'n' operations on 'n' machines - Scheduling rules - loading problems - Tool management of FMS - material Handling system schedule. Problems. Inspection & Cleaning stations. CMM**,** Sequence of operations, Advantages Types of CMM, Problems.	**09**
7	**FMS Relational:** Economic and technological justification for FMS – as GT, JIT – operation and evaluation - Personnel and infra structural aspects – typical case studies – Future prospects.	**07**
	Total	**45 Hours**

Text Books:

1. Parrish D J (1993), "Flexible manufacturing", *ButterWorth – Heinemann Ltd Oxford.*
2. Groover M P (1989), "Automation, Production Systems and Computer Integrated Manufacturing", *Prentice Hall India (P) Ltd.*
3. Kusiak A (1990), "Intelligent Manufacturing Systems", *Prentice Hall, Englewood Clitts, NJ.*
4. William W. Luggen, "Flexible Manufacturing Cells & Systems", *Prentice hall, NJ*

Reference Books:

1. Considine D M (1986), "Standard Handbook of Industrial Automation", *Chupman and Hall, London.*
2. Viswanatham N & Narahari Y (1992), "Performance Modeling of Automated Manufacturing Systems", *Prentice Hall of India (P) Ltd.*
3. Ranky P G (1988), "The design and Operation of FMS", *IFS Pub. UK.*
4. Dr. H. K. Shivanand, "Flexible Manufacturing System", *Dhanpat Rai Publications, New Delhi.*

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Term Work:

1. Assignments based on the above syllabus (Min. 4).
2. Visit to FMS unit.
3. Viva Voce, Quizzes, Presentations based on syllabus.
4. Two term test papers.

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SVKM's Narsee Monjee Institute of Management Studies
Mukesh Patel School of Technology Management and Engineering

Program: B. Tech. (Mechatronics Engineering)				**Semester : VII**	
Course: (Elective I) - Automobile Engineering				**Code:** BTMA07006	
Teaching Scheme				**Evaluation Scheme**	
Lecture Hours per week	**Practical Hours per week**	**Tutorial Hours per week**	**Credit**	**Internal Continuous Assessment (ICA) As per Institute Norms (Marks – 50)**	**Theory (3 Hrs., 70 Marks)**
3	0	2	4	Scaled to 30 marks	Scaled to 70 marks

Pre-requisite: Theory of Machines II (BTMA04003),
Design of Machine Elements (BTMA05001)

Objective:

- To impart the knowledge of the basics of the automobiles.
- To introduce the different automobile systems like suspension, axles and steering and transmission systems in the Automobiles.

Outcomes:

After successful completion of this course, students should be able to

- Understand the types of engines used in automobile and their characteristics, selections of suitable rear axle, gear etc.
- Analyze the chassis layout, steering geometry, types of suspensions, and clutch and gear mechanism of vehicle.
- Perform the calculations of clutch and Brakes.

Detailed Syllabus

Unit	Description	Duration (Hours)
1	**Vehicle Performance:** Types of engines used in automobiles, their characteristics and selections, resistance to motion of vehicle, air, rolling and gradient resistances, power requirement for acceleration and tradability, selection of suitable rear axle and gear ratios.	**06**
2	**Chassis:** Chassis layout, power plant location, types of automobiles, weight distribution stability, type of frame, materials.	**04**
3	**Steering:** Steering geometry, wheel alignment and wheel balancing, center point Steering, Ackerman and Davis steering, cornering force slip angle, scrub radius, steering conventional layout of steering system. Steering systems for independent suspension, wheel wobble and shimmy, power steering. **Axle:** Axle material, load and stresses on front axle design, steering heads, axle bearing wheel alignment, differential and their types, rear axle arrangements, two speed rear axle, single, double and triple reduction rear axles.	**12**

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	Tires: Function, construction, types of tires, tubeless tire.	
4	**Suspension System:** types of suspensions, materials, shackles and mountings, types of springs, shock absorbers, sprung weight and un sprung weight, conventional suspension system, independent suspension, air suspension, hydra-gas suspension, rubber suspension, interconnected suspension, self-leveling suspension	**08**
5	**Drive mechanisms:** Torque reaction, driving thrust, propeller shaft, universal joints, and constant velocity universal joints. Differential, action of differential, constructional details, types of rear axles, materials, bearing loads, double reduction and two speed axle, front wheel drive, all-wheel drive, introduction to continuous variable transmission (CVT).	**07**
6	**Clutch and braking mechanisms:** **Clutch:** Clutch mechanism-wet/dry clutch- constant pressure, constant wear type, back up plate, cone clutch, centrifugal clutch, multi-plate clutch, clutch materials, influence of temperature on the performance, torque limiter. Numerical Examples. **Braking Systems**: types and construction, mechanical, hydraulic system, diagonal braking system, antilock braking system. Numerical Examples.	**08**
	Total	**45 Hours**

Text Books:

1. K. K. Jain and Asthana (2002), "Automobile Engineering", *TTI Publications*.
2. R.K. Rajput (2007), "A Text Book of Automobile Engineering", *Laxmi Publications*.
3. S. Kripal (2009), "Automobile Engineering Vol I", *New Chand Jain*.

Reference Books:

1. G. Genta, Morello (2009), "The Automotive Chassis: System Design", *Springer*.
2. Society of Automotive Engineering (1997), "Automotive Engineering".
3. D. Crolla (2009), "Automotive Engineering: Powertrain, Chassis System, Vehicle, Body", *Butterworth- Heinemann*.

Term Work:

1. One assignment from each unit.
2. Experiments (any 5) from the list given below
3. Study of Engines, systems and mechanisms of vehicles with sketches and write ups.
4. Viva Voce /Presentations
5. Two term test papers.

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List of Experiments:

1. Study of Chassis Layout.
2. Study of Power plant location and mounting.
3. Study of Steering mechanism and Power Steering.
4. Experiment on wheel balancing.
5. Experiment on Suspension system (coil spring and leaf spring) mounting and design calculations.
6. Study of Universal joint and differential mechanism.
7. Study of Clutches of different types.
8. Study of construction of mechanical, hydraulic and pneumatic brakes.

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Program: B. Tech. (Mechatronics Engineering)				**Semester : VII**	
Course : (Elective II) - Digital Signal Processing				**Code:**BTMA07007	
Teaching Scheme				**Evaluation Scheme**	
Lecture Hours per week	**Practical Hours per week**	**Tutorial Hours per week**	**Credit**	**Internal Continuous Assessment (ICA) As per Institute Norms (Marks – 50)**	**Theory (3 Hrs., 70 Marks)**
3	2	0	4	Scaled to 30 marks	Scaled to 70 marks

Pre-requisite: Signals and systems (BTMA 04002)

Course Objectives:

1. Understand different types of linear systems
2. Understanding various discrete transforms
3. Designing of filters

Course Outcomes:

At the end of this course students will be able to

1. Understand the importance of linear phase systems.
2. Use various transforms like DCT and DFT.
3. Design Finite Impulse Response and Infinite Impulse response filters.

Detailed Syllabus:

Unit	Description	Duration (Hours)
1	**Properties of LTI systems:** Definition, convolution and solution of Linear difference equations with constant coefficients. Causality & stability, Frequency response of LTI systems, phase distortion and delay, all pass systems, minimum, maximum mixed phase systems, linear phase filters, causal generalized linear phase system (pole zero plots), symmetric, anti-symmetric filters & review of low pass, high pass, band pass filters, frequency transformations, digital resonator, comb filters, notch filters, digital sinusoidal oscillators	09
2	**Discrete cosine transform (DCT):** Definition of DCT, DCT-1 and DCT-2, relationship between FT ,DCT-1 and DCT-2, energy compaction property of DCT-2, applications of DCT	04
3	**Discrete Fourier transform:** DFT and its properties, multiplication of two DFTs- the circular convolution, additional DFT properties, use of DFT in linear filtering, overlap-save and overlap-add method, Fast	07

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	Fourier transform radix 2, radix 4, application of FFT algorithm, Decimation in Time FFT, Decimation-in-Frequency FFT, Inverse FFT	
4	**Design of filters:** Design of FIR filters - windowing method frequency sampling method, FIR differentiator, Hilbert transformers, relationship between no. of coefficients and filters, characteristics of raised cosine transition filter. Design of IIR filters: Mapping of differentials, Impulse invariance, Bilinear transformation, Matched Z-transforms, Butterworth, Chebyshev filter I, Chebyshev filter II, and Elliptic filters Frequency transformation low pass to high pass, band pass, band reject filters, Design of digital filter based on least square method	**10**
5	**Structures for discrete time systems:** - FIR structures (direct form, cascade form, frequency sampling and lattice); structures for linear phase filters. - Structures for IIR systems, direct form-I, Direct form-II, Canonical, Lattice and Lattice ladder structures. - Basic structure of phase shifters, All-pass filters; analysis of cascaded and parallel IIR structures and FIR structures	**07**
6	**Amplitude quantization**: effect of coefficient quantization in IIR and FIR systems, effect of round off noise in digital filters, quantization errors, limit-cycle oscillations.	**02**
7	**Introduction to Programmable Digital Processor** DSP processor v/s General purpose processor, multiplier, MAC unit, Bus Architecture and memory, Pipelining, Multiport memory, VLIW Architecture, data addressing capabilities, on-chip Peripherals, P-DSPs with RISC and CISC	**06**
	Total	**45 Hours**

Text Books:

1. John Proakis, Digital Signal Processing, Prentice Hall of India Publication, 4th edition, 2010
2. S. K. Mitra. Digital Signal Processing: A Computer-Based Approach, McGraw-Hill, New York, NY, fourth edition, 2010.

Reference Books:

1. Alan V. Oppenheim & Ronald W. Scheffer, Discrete time signal processing, Prentice Hall of India Publication, Third edition, 2009
2. F.W. Smith, Scientist & Engineers' Guide to Digital Signal Processing (e-book) (California Technical Publishing). Web-site : www.DSPguide.com
3. Maurice Bellanger, Digital Processing of signals, (John Wiley Publication) 2000

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Term Work:

1. Minimum two assignments.
2. Minimum ten experiments covering the whole syllabus duly recorded and graded.
3. Two term test papers.

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Program:	**B. Tech. (Mechatronics Engineering)**			**Semester : VII**	
Course :	(Elective II) - Microcontroller and Embedded Systems			**Code:** BTMA07008	
Teaching Scheme				**Evaluation Scheme**	
Lecture Hours per week	**Practical Hours per week**	**Tutorial Hours per week**	**Credit**	**Internal Continuous Assessment (ICA) As per Institute Norms (Marks – 50)**	**Theory (3 Hrs., 70 Marks)**
3	2	0	4	Scaled to 30 marks	Scaled to 70 marks

Pre-requisite: Digital Electronics (BTMA03004) and Microprocessors and Interfacing (04006)

Objectives:

1. To introduce to the students 8 bit Microcontrollers.
2. To understand the assembly and "C" language and write code for applications.

Outcomes:

After the successful completion of this course the student will be able to

1. Explain the difference between microprocessors and microcontrollers and learn 8051 microcontroller.
2. Design microcontroller based systems for different applications.
3. Know the basics of PIC18xx controller.
4. Discuss different embedded systems and their use.
5. Explain the concept of RTOS and its selection criteria.

Detailed Syllabus:

Unit	**Description**	**Duration (Hours)**
1.	**Basics of 8051:** Comparison of microprocessor and microcontroller, Architecture and pin functions of 8051 chip controller, CPU timing and machine cycles, Internal memory organization, Program counter and stack, Input/output ports, · Counters and timers, Serial data input and output ·Interrupts, Power saving modes.	**08**
2.	**Programming with 8051:** Instruction set, addressing modes, immediate, registers, direct and indirect data movement and exchange instructions, push and pop op-codes, arithmetic and logic instructions, bit level operations, jump and call instructions, input/ output port programming, Programming timers, asynchronous serial data communications, and	**09**

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	hardware interrupt service routines. Interfacing of LCD display, hex keyboard, ADC0808, DAC0808 and Stepper motor with 8051 Current trends in microprocessors and practical implementation	
3.	**PIC Controllers: PIC18** PIC18 memory organization, CPU registers, Pipelining, instruction format, Addressing modes, Sample of PIC18 Instructions. Overview of the 8-bit MCU Market	**07**
4.	**PIC18 Assembly language Programming** Assembler directives, Writing programme to perform arithmetic computations, program loops, Reading and writing data in programmed memory, Logic Instructions, Using programmed loop to create time delays, Rotate instructions, Using rotate instructions to perform Multiplications &divisions. I/O Addressing, Interfacing with simple input/output devices.	**08**
5.	**Introduction to Embedded systems** Architecture of Embedded Systems, Design Metrics, Examples of embedded systems, hardware/software co-design, Embedded micro controller cores (ARM, RISC, CISC, and SOC), embedded memories, sensors and interfacing techniques.	**07**
6.	**Real-time operating system(RTOS)** RTOS concepts, real-time operating systems, Required RTOS services/capabilities (in contrast with traditional OS). Benefits of using RTOS, Concepts of Tasks/Threads/Process, Multitasking, Task Scheduling, Task management, Inter-task communication and Synchronization, Device Drivers, How to choose an RTOS	**06**
	Total	**45 Hours**

Text Books:

1. Muhammad A. Mazidi, "The 8051 microcontroller and embedded system", Pearson Education Asia, 2nd edition, 2008.
2. Han Way Huang, "PIC Microcontroller", Cengage learning, 2009
3. Rajkamal, "Embedded Systems - Architecture, Programming and Design", Tata McGraw Hill, 2nd edition, 2009.

Reference Books:

1. Kenneth J Ayala, "The 8051 microcontrollers", Thomson, 3rd edition, 2006
2. John B. Peatman, "Design with PIC Microcontrollers", Pearson Education, 2nd edition 2010
3. David E. Simon, "An Embedded Software Primer", Pearson Education, 1999.

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Term Work:

1. Minimum two assignments.
2. Minimum ten experiments covering the whole syllabus duly recorded and graded.
3. Two term test papers.

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SVKM's Narsee Monjee Institute of Management Studies
Mukesh Patel School of Technology Management and Engineering

Program:	**B. Tech. (Mechatronics Engineering)**			**Semester : VII**	
Course :	(Elective II) - Microelectromechanical Systems			**Code:** BTMA07009	
Teaching Scheme				**Evaluation Scheme**	
Lecture Hours per week	**Practical Hours per week**	**Tutorial Hours per week**	**Credit**	**Internal Continuous Assessment (ICA) As per Institute Norms (Marks – 50)**	**Theory (3 Hrs., 70 Marks)**
3	2	0	4	Scaled to 30 marks	Scaled to 70 marks

Pre-requisite: Fundamentals of science and Instrumentation (BTMA05004)
Engineering

Objectives:

1. To develop certain skills related to MEMS performance and miniaturization
2. To understand low cost production of sensor and actuator system and biomedical systems
3. To expose students to materials properties, fabrication techniques, sensing and actuation principles, circuit and system issues, packaging, calibration and testing.

Outcomes: After successfully completion of this course, students will be able to

1. Able to learn fabrication techniques used MEMs manufacturing.
2. Able to determine the performance of MEMs design.
3. Implement advanced MEMs design flow used in the semiconductor industry

Detailed Syllabus:

Unit	**Description**	**Duration (Hours)**
1	**MEMS and Microsystems Technology:** Introduction to Micro sensors, Evolution of micro sensors, Microelectronics technologies for MEMS, Mechanical, Inertial, Biological, Chemical, Acoustic technology.	**08**
2	**Sensor network and Protocol:** Actuating or sensing concept, Integrated smart sensors Smart transducers: Concept, hardware structure , software structure	**08**
3	**MEMS Fabrication:** Background in MEMS fabrication for advance R & D. Surface	**08**

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	micromachining and bulk micromachining. Non-lithographical micromachining such as LIGA and laser-assisted processing. Mechanical properties of thin film and residual stress. Process integration and issue of thermal budget.	
4	**Nanoscience and Biotechnology:** Basic physical, chemical, and biological principal in Nanoscience. Nanoscale material prepared by various methods. Top-down and bottom-up nanofabrication techniques. Nano characterization. Application of Nano technology on electronics, biology, medicine, energy, environment.	**08**
5	**MEMS market and application:** MEMS for RF application, Bonding and Packaging of MEMS, Application in automotive and Biomedical industry, Calibration and testing, Future development.	**08**
6	**Case Study:** Visit MEMs manufacturing plant to do a case study and prepare report.	**05**
	Total	**45 Hours**

Text Books:

1. Tai-Ran Hsu , "MEMS and Microsystems: design , manufacture, and nanoscale engineering," 2nd Edition, by, John Wiley & Sons, Inc., Hoboken, New Jersey, 2008
2. Liu, Chan, Foundation of MEMs, 1st edition, Prentice Hall , 2006

Reference Books:

1. Stephen D. Senturia, Microsystems Design, Kluwer, Boston, 2001
2. Marc J. Madou, Fundamentals of Micro-fabrication, Fifth Printing, CRC Press, 2000

Term Work:

1. Minimum two assignments.
2. Minimum ten tutorials and assignments covering the whole syllabus duly recorded and graded.
3. Two term test papers.

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SVKM's Narsee Monjee Institute of Management Studies
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Program:	**B. Tech. (Mechatronics Engineering)**			**Semester : VIII**	
Course :	Industrial Robotics			**Code:** BTMA08001	
Teaching Scheme				**Evaluation Scheme**	
Lecture Hours per week	**Practical Hours per week**	**Tutorial Hours per week**	**Credit**	**Internal Continuous Assessment (ICA) As per Institute Norms (Marks – 50)**	**Theory (3 Hrs., 70 Marks)**
3	2	0	4	Scaled to 30 marks	Scaled to 70 marks

Pre-requisite: Linear Algebra, Vectors and Matrix (BTAB01001), (BTAB02001)

Objectives:

1. To provide knowledge to students with the concepts and techniques in robot manipulator control.
2. To expose students to evaluate, choose and incorporate robots in engineering systems and programming of robots.
3. To understand and analyze the various applications of robots.

Outcomes:

After the successful completion of this course, the student will be able to

1. Know the basics of Robots.
2. Apply the knowledge of vectorial mathematics and geometry for kinematics (Direct and Inverse) motion.
3. Perform trajectory planning and work space analysis for robots.
4. Use image representation for robotic movement.
5. Perform autonomous mobile robot kinematics.

Detailed Syllabus:

Unit	**Description**	**Duration (Hours)**
1.	**Basic Concepts in Robotics** Introduction, Advantages & Applications of Robots, Automation and Robots, Non-Industrial applications, Basic structures of Robots, Numerical control of Machine tools, Resolution, Accuracy & Repeatability, Position Representation. Point to Point Continuous path systems, Point to Point Robotic systems, Continuous – path Robotic systems, Control loop of Robotic Systems, The Manipulator, Cartesian Coordinate Robots, Cylindrical Coordinate robots, Spherical Coordinate robots, Articulated Robots	**07**
2.	**Kinematic Analysis & Coordinate Transformation** Direct Kinematic Problem in Robotics, Geometry based direct Kinematic	

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	Analysis Coordinate & Vector Transformation using Matrices, The orientation Matrix & Translator Vector, Homogeneous Transformation Matrices, Three dimensional Homogeneous Transformations, Denavit Hartenberg Convention-Implementing the DH Convention, Obtaining the DH Displacement Matrices. Applications of DH method- Three axis Robot Arms, Three Axis wrists, Six axis Robot Manipulators, Assigning the Tool Coordinate System.	**08**
3.	**Inverse Kinematics:** General properties of solution, tool configuration vector for: Two axes planar articulated robot arm, Three axis robot, Four axis robot, and Five axis robot. Inverse kinematics analysis of Two axes planar articulated robot arm, Three axis robot, and Four axis robot.	**06**
4.	**Workspace Analysis and Trajectory Planning of Robots:** Robot work space envelops and examples, Detailed Work space analysis of two axis planar articulated robot arm, Four axis robot. Different type of motions such as Pick and place motions, Continuous path motion, interpolated motion, Straight-line motion, workspace fixtures.	**08**
5.	**Robot Vision:** Image representation and analysis, Template matching, polyhedral objects, shape analysis, Segmentation (Thresholding, region labelling) Iterative processing, Perspective transformation, Structuring Illumination, Camera calibration.	**08**
6.	**Task Planning:** Task planner, Task level programming, Uncertainty, Configuration, Space, Gross motion, Planning, grasp planning, Fine-motion, Simulation of Planar motion.	**04**
7.	**Autonomous Mobile Robots:** Introduction, Locomotion - Key issues for locomotion, Legged Mobile Robots, Leg configurations & stability , Examples of legged robot locomotion , Wheeled Mobile Robots, Wheeled locomotion-the design space, Wheeled locomotion: case studies	**04**
	Total	**45 Hours**

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Text Books:

1. Fu, Gonzales and Lee, Robotics- Control, Sensing, Vision and Intelligence, McGraw Hill, 1st edition, 2008.
2. Robert Schilling, Fundamentals of Robotics-Analysis and control, Prentice Hall of India, 1990. **(Classic)**

Reference Books:

1. J. J. Craig, Introduction to Robotics, Pearson Education, 8th edition, 2004

2. Roland Siegwart & Illah R Nourbaksh, "Introduction to Autonomous Mobile Robots", EEE ed PHI 2004

3. Mittal and Nagrath, Robotics and Control, Tata McGraw Hill, 3rd edition, 2003

Term Work:

1. Minimum two assignments.
2. Minimum ten experiments covering the whole syllabus duly recorded and graded.
3. Two term test papers.

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SVKM's Narsee Monjee Institute of Management Studies
Mukesh Patel School of Technology Management and Engineering

Program: B. Tech. (Mechatronics Engineering)				**Semester: VIII**	
Course: Product Design and Development				**Code:** BTMA08002	
Teaching Scheme				**Evaluation Scheme**	
Lecture Hours per week	**Practical Hours per week**	**Tutorial Hours per week**	**Credit**	**Internal Continuous Assessment (ICA) As per Institute Norms (Mark – 50)**	**Theory (3 Hrs., 70 Marks)**
3	0	2	4	Scaled to 30 marks	Scaled to 70 marks

Pre-requisite: Manufacturing Processes (BTMA04005)

Objective:

- To provide the understanding of the development and design aspects of products.
- To impart knowledge of business and technical concerns about the different methodologies of product development.
- To introduce concept of product life cycle and product data management.

Outcomes:

After successful completion of this course, students should be able to-

- Understand different stages of product development and design with modern approaches.
- Know the importance of Technology Forecasting using S-Curve in new product development.
- Benchmark products and technologies.
- Understand Product Life Cycle concept and its importance in product development phase.
- Use techniques like QFD and DFX for product design.

Detailed Syllabus

Unit	Description	Duration (Hours)
1	**Introduction to Product Design and Development:** Definition of product design, design by evolution and innovation, factors in product design, morphology of product design (seven phases), standardization, simplification and specialization in product design, modern approaches- concurrent design and quality function deployment, product development, product development versus product design, types of design and redesign, modern product development process, product development team and product development planning with reference to ISO standard, difference between product verification and production validation, introduction to prototyping, rapid prototyping methods.	12
2	**Product Development – Technical and Business Concerns:** Technology Forecasting and Technology S-Curve (Technology Stage), Mission Statement and Technical Questioning, Economic Analysis of Product, Customer Needs	09

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	and Satisfaction, Customer Population and Market Segmentation, Customer Needs-Types and Models, Gathering Customer Needs Information, Analysis of Gathered Information.	
3	**Product Development from Concept to Product Function:** Generating concepts, information gathering and brainstorming, morphological analysis, concept selection-design evaluation, estimation of technical feasibility, concept selection process, Pugh's concept, selection charts, numerical concept scoring, process of concept embodiment, system modeling, Failure Mode Effect Analysis (FMEA), functional modeling and decomposition, fast method, subtract and operate procedure, establishing system functionality, augmentation and aggregation.	**12**
4	**Quality function deployment (QFD)**: Quality function deployment studies to validate design characteristics; Affinity diagram, Tree diagram, Matrix diagram, Prioritization matrix; Design validation	**06**
5	**Design for 'X' (DFX):** Design for manufacture, assembly, testing, maintenance, service, reliability; Product safety and hazard evaluation; Final disposal; Reverse Engineering.	**06**
	Total	**45 Hours**

Text Books:

1. K. Otto and K. Wood (2009), "Product Design –Techniques in Reverse Engineering and New Product Development", *Pearson Education*.
2. K. T. Ulrich and S. D. Eppinger (2008), "Product Design and Development", *Tata McGraw Hill*.

Reference Books:

1. R. Rosenthal (2000), "Effective Product Design and Development", *Business One-Irwin S Publication*.
2. E.B. Magrab, S.K. Gupta, F. Patrick (2009), "Integrated Product and Process Design and Development-The Product Realization Process", *CRC press*.

Term work:

1. Assignments based on syllabus (Min. 5).
2. Viva voce/Presentations/Quizzes
3. Two term test papers.

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SVKM's Narsee Monjee Institute of Management Studies
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Program:	**B. Tech (Mechatronics Engineering)**			**Semester : VIII**	
Course :	Project Phase - II			**Code:** BTMA08003	
Teaching Scheme				**Evaluation Scheme**	
Lecture Hours per week	**Practical Hours per week**	**Tutorial Hours per week**	**Credit**	**Internal Continuous Assessment (ICA) As per Institute Norms**	**Theory ---**
0	8	0	4	Scaled to 100 Marks	---

Pre-requisite: Project Phase I

Objectives:

1. To be able to build/simulate circuit.
2. To be able to test and validate the results.

Outcomes:

1. Implementation of the model.
2. Validate and troubleshoot the model
3. Summarize the topic into a technical report and demonstrate the model.

Activities to be done in phase II:

1. The second phase of the project will involve development implementation and testing of the project.
2. Student is required to submit a 1-2 pages weekly report on the work done to the mentor. There would continuous evaluation based on the weekly report submitted.
3. Report primarily containing the entire overview of the Project from Literature Survey, Feasibility Study, Design, Analysis, Implementation, and Testing is to be submitted at the end of the Semester. (Hard Bound Report (Golden Embossing))
4. Presentation (about 30 minutes) of the work done during the semester to be evaluated by Internal Examiner and External Examiner.

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Program: B. Tech. (Mechatronics Engineering)				**Semester: VIII**	
Course: (Elective III) - Project Management				**Code:** BTMA08004	
Teaching Scheme				**Evaluation Scheme**	
Lecture Hours per week	**Practical Hours per week**	**Tutorial Hours per week**	**Credit**	**Internal Continuous Assessment (ICA) As per Institute Norms (Marks – 50)**	**Theory (3 Hrs., 70 Marks)**
3	0	2	4	Scaled to 30 marks	Scaled to 70 marks

Prerequisite: Nil

Objectives:

- To introduce aspects of project management such as formulation, planning, scheduling and control of project.
- To provide with a high level overview of project management.
- To impart knowledge associated with planning, budgeting, scheduling, controlling, and terminating a project.

Outcomes :

After successful completion of this course, students should be able to

- Understand the process of Project Management.
- Create a work breakdown structure with specifications
- Apply cost estimating and budgeting methods to a project
- Identify important risks facing a new project.
- Apply appropriate techniques to assess ongoing project performance.

Detailed Syllabus

Unit	Description	Duration (Hours)
1	**Introduction to project management**: Definition, Function, evolution of project management , classification of project management in different environments	03
2	**The project management systems, methodologies and systems development cycle**: Scope, systems approach, project feasibility, project life cycle, the phases of systems development cycle.	04

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3	**Project Planning**: Planning fundamentals, project master plan, work breakdown structure and other tools of project planning, work packages project organization structure and responsibilities, responsibility matrix.	**06**
4	**Project Scheduling**: Use of Gantt charts and network diagrams, activity of node diagrams, activity on arrow diagrams the critical path, time based networks.	**04**
5	**PERT, CPM, Resource Allocation Introduction to** Tools and techniques for scheduling development, crashing of networks, time-cost relationship, Resource leveling multiple project scheduling.	**05**
6	**Cost Estimating and Budgeting**: Cost estimating process elements of budgeting, Project cost accounting and management information systems, cost schedules and forecasts.	**05**
7	**Managing Risks in Projects**: Risk concepts and identification, risk assessment, risk priority, risk response planning, risk management methods.	**04**
8	**Project Control**: Information monitoring, internal and external project control, cost accounting systems for project control, control process, performance analysis, variance limits, and issues in project management software (MS Projects).	**05**
9	**Project Evaluation, Reporting and termination:** Project reviews and reporting, closing the contract.	**04**
10	**Project organization structure and integration** :Requirement of project organizations, different structure and integration in large scale projects, roles of project manager and project team	**05**
	Total	**45 Hours**

Text Books:

1. John M. Nicholas (2001), "Project Management for Business and Technology", 2nd Edition, *Pearson Education Asia*.

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2. Jack R Meredith, Samuel J Mantel (2000), "Project Management –A Managerial Approach", 4th Edition, *JW and Sons*.
3. Choudhury (2006) "Project Management", *Tata McGraw Hill*.

References Books:

1. Dennis Lock, Gower (2003), "Project Management", 8th Edition.
2. Norman R Howes (2001), "Modern Project Management", *Amacom*.
3. Prasanna Chandra (2004), "Projects: Planning, Analysis, Selection, Implementation and Review", 5th Edition, *Tata McGraw Hill*.
4. Gido and Clements (2003), "Successful Project Management", 2nd Edition, *Thomson*.

Term Work:

1. Assignments based on the syllabus (Min 3).
2. Seminar or Presentation on topic based on syllabus.
3. Viva Voce
4. Two term test papers.

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SVKM's Narsee Monjee Institute of Management Studies
Mukesh Patel School of Technology Management and Engineering

Program: B. Tech. (Mechatronics Engineering)				**Semester:** VIII	
Course: (Elective III) - Additive Manufacturing				**Code:** BTMA08005	
Teaching Scheme				**Evaluation Scheme**	
Lecture Hours per week	**Practical Hours per week**	**Tutorials Hours per week**	**Credit**	**Internal Continuous Assessment (ICA)As per Institute Norms (Marks -50)**	**Term End Examinations (TEE) Theory (3 Hrs, 70 Marks)**
3	2	0	4	Scaled to 30 marks	Scaled to 70 marks

Pre-requisite: Manufacturing Processes (BTMA04005, CAD/CAM/CIM (BTMA06006)

Objectives:

- Acquire introductory knowledge of Additive Manufacturing and applicability of AM in modern customer-oriented manufacturing industry.
- To get acquainted with the operating principles of most prominent technologies in the field of Additive Manufacturing.
- Finding the common software issues associated with AM and addressing it using file repair algorithms.

Outcomes:

After completion of the course, students would be able to:

- Understand the importance of Additive Manufacturing and identifying various industrial sectors where it can be applied.
- Include AM as a critical tool in the product design cycle and to rapidly develop prototypes, thereby reducing the lead time
- Understand and operate FDM 3D Printers.
- Identify enterprising opportunities in the field of Additive Manufacturing.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1	**Introduction to Additive Manufacturing (AM):** Introduction to AM, History of AM, Why use the term Additive Manufacturing, Distinction between AM, CNC & other digital manufacturing techniques, Advantages of AM, Classifications of AM processes. Design for Additive Manufacturing (DFAM)	**03**

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2	**Additive Manufacturing Process Chain:** Basic eight steps in AM Process Chain, 3D Modelling, Data Conversion and Transmission, Checking and Preparing, Building, Post processing, Application.	**07**
3	**Liquid-Based Processes:** Introduction, Photo-polymerization-Basic overview, Stereolithography (SL) Process overview, Other liquid-based processes: Solid Ground Curing (SGC), Solid Creation System (SCS), Solid Object Ultraviolet-Laser Printer (SOUP), Rapid Freeze Prototyping, Microfabrication.	**07**
4	**Powder Bed Fusion Process:** SLS process overview, Powder fusion mechanism, Powder handling, Metal and Ceramic powder processing, Other powder based processes- EOSINT Systems, Three-Dimensional Printing (3DP), Laser Engineered Net Shaping (LENS), Direct Shell Production Casting (DSPC), Multiphase Jet Solidification (MJS), Electron Beam Melting (EBM).	**08**
5	**Extrusion-Based Processes:** Fused deposition modelling, Basic principle and process, FDM machines type, Materials used in FDM, Other extrusion based processes-Multi-Jet Modelling System (MJM), Contour Crafting, Nonplanar System, FDM of Ceramics,	**07**
6	**Software Issues for Additive Manufacturing:** Conversion of CAD model into STL file, Issues with STL file, STL file manipulation, Other Translators, Newly Proposed Formats.	**07**
7	**Applications and Examples:** Medical application, software for medical application, Applications in Design, Aerospace Industry, Automotive Industry, Biomedical Industry, Jewelry Industry.	**03**
8	**Business Opportunities in Additive Manufacturing:** Product Development, Product Evolution, Supply Chain Evolution, Business Model Evolution, Digipreneurship,	**03**
	Total	**45**

Text Books:

1. Gibson I, Rosen D W, Stucker B (2010), "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", *Springer.*
2. Chua, C. L., Lim, K., (2003), "Rapid Prototyping: Principles and Applications", *World Scientific Publishing Co. Pte. Ltd.*

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3. Noorani, R. (2006), "Rapid prototyping: Principles and Applications", *John Wiley & Sons Incorporated.*
4. Kamrani, A. K., & Nasr, E. A. (2006), "Rapid prototyping: theory and practice", (Vol. 6), Springer *Science & Business Media.*

Reference Books:

1. Pham, D., & Dimov, S. S. (2012), "Rapid manufacturing: the technologies and applications of rapid prototyping and rapid tooling", *Springer Science & Business Media.*
2. Gebhardt, A., & Gebhardt, A. (2012), "Understanding Additive Manufacturing", *Hanser Publications*

Term Work:

1. Mini Project and/or Case Studies
2. Experiments as per the list provided (min 8)
3. Industrial Visit and report

List of Experiments:

1. Review of CAD Modelling Software packages (AutoCAD, CATIA, SOLIDWORKS, CREO or any other suitable package) and modelling of 3D model using any one software.
2. Understanding the working of Leapfrog Creator FDM 3D printer and its software interface.
3. Processing the CAD data in Repeater software or Slicer (Selection of Orientation, Supports generation, Slicing, Tool path generation).
4. Understanding the properties of various plastic filament used in FDM printers
5. Fabricating the 3D models on FDM RP machine
6. Fabricating the 3D models with and without supports
7. Working with CAD Data Exchange formats: IGES, ACIS, DXF and STL
8. Identification of STL file problems using MAGICS software repairing the models
9. Converting CT/MRI scan data into STL file using MIMICS software (Demo)
10. Studying the machinability properties of 3D printed parts.

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SVKM's Narsee Monjee Institute of Management Studies
Mukesh Patel School of Technology Management and Engineering

Program: B. Tech. (Mechatronics Engineering)				**Semester: VIII**	
Course: (Elective III) - Reliability Engineering				**Code:** BTMA08006	
Teaching Scheme				**Evaluation Scheme**	
Lecture Hours per week	**Practical Hours per week**	**Tutorial Hours per week**	**Credit**	**Internal Continuous Assessment (ICA) As per Institute Norms (Marks – 50)**	**Theory (3 Hrs., 70 Marks)**
3	0	2	4	Scaled to 30 marks	Scaled to 70 marks

Prerequisite: Engineering Mathematics - I & II (BTAB01001 & BTAB02001)

Objective:

- To understand the concept of reliability and its significance in manufacturing of critical components / assemblies / systems.
- To familiarize with failure analysis techniques of reliability improvement, reliability testing and predictions.

Outcomes:

After successful completion of this course, students should be able to

- Understand the Reliability terminology and its interrelationship with quality for evaluation of safety standard.
- Understand and write the derivations on mean life, median life and model life of different distributions.
- Conduct Product Reliability Acceptance tests, Stress screening, Degradation Tests, MTBF, CI, Hypothesis Testing, Goodness of Fit, Kolmogorov-Smirnov test, Anderson Darling Test.

Detailed syllabus

Units	**Description**	**Duration (Hours)**
1	Reliability program management, Benefits of reliability engineering, Interrelationship of quality and reliability, Failure consequence and liability management, Integrated reliability program, concurrent engineering System Safety and evaluation of its conformance to standards Safety labels, Reliability Terminology	**05**
2	Mathematical definition of reliability and unreliability, hazard function, cumulative hazard function, reliability function, mean life, median life, modal life	**04**
3	Typical Life-time distributions (Poisson, Exponential, Weibull, Gamma, Beta), derivations of mean life, variance, median life etc. for different distributions	**04**

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4	Ranking of life data, probability plotting, Poisson process, non-repairable and repairable systems, bath-tub curve for repairable system	**04**
5	Reliability design techniques, Use factors, Stress-strength analysis Introduction to FMEA and FMECA from reliability perspective, Fault tree analysis (FTA) in design, Monte Carlo simulation	**05**
6	Reliability of Mechanical components and systems, Fatigue, S-N Diagram, Miner's rule, Effects of Creep, Wear, Corrosion, Vibration and shock, Temperature	**04**
7	Reliability modeling and prediction, Reliability block diagrams and models, part count predictions and part stress analysis, reliability prediction methods for repairable and non-repairable devices, Reliability apportionment, reliability allocation	**05**
8	Development testing, elements of a reliability test plan, Accelerated life tests (e.g., single-stress, multiple-stress, sequential stress), Step-stress testing	**04**
9	Product testing, Qualification/Demonstration testing (Sequential tests, Fixed length tests), Product Reliability Acceptance tests, Stress screening, Degradation Tests, MTBF, CI, Hypothesis Testing, Goodness of Fit, Kolmogorov-Smirnov test, Anderson Darling Test	**05**
10	Maintainability and availability, Maintainability and availability planning, Maintainability apportionment/allocation, Availability tradeoffs, Maintenance time distributions, Preventive and Corrective maintenance (PM) analysis.	**05**
	Total	**45 Hours**

Text Books:

1. P. D. T. O. Connor (2012), "Practical Reliability Engineering", *John Wiley*.
2. "NY's RAC sheets on Reliability Engineering", (1998), *System Reliability Center, Rome*.

Reference Books:

1. R. A. Johnson (2007), "Probability and Statistics for Engineers", *PHI Publications*.
2. Juran (2010), "Quality Hand Book", *Tata McGraw Hill*.

Term Work:

1. Assignments based on the topics of the syllabus (Min. 3).
2. Seminar or presentation on topic based on syllabus.
3. Viva voce.
4. Two term test papers.

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SVKM's Narsee Monjee Institute of Management Studies
Mukesh Patel School of Technology Management and Engineering

Program: B. Tech. (Mechatronics Engineering)				**Semester: VIII**	
Course : (Elective IV) - Virtual Instrumentation				**Code:** BTMA08007	
Teaching Scheme				**Evaluation Scheme**	
Lecture Hours per week	**Practical Hours per week**	**Tutorial Hours per week**	**Credit**	**Internal Continuous Assessment (ICA) As per Institute Norms (Marks – 50)**	**Theory (3 Hrs., 70 Marks)**
3	2	0	4	Scaled to 30 marks	Scaled to 70 marks

Pre-requisite: Instrumentation (BTMA05001), Basic Electrical Engineering (BTAB01003), Basic Electronics (BTAB02003)

Objectives:

1. To review background information required for studying virtual instrumentation.
2. To study the basic building blocks of virtual instrumentation.
3. To study the various techniques of interfacing of external instruments of PC.
4. To study the various graphical programming environment in virtual instrumentation.
5. To study a few applications in virtual instrumentation.

Outcomes:

After the successful completion of this course the student will be able to

1. Build blocks of virtual instrumentation.
2. Do graphical program in virtual instrumentation.
3. Study applications in Virtual Instrumentation.

Detailed Syllabus:

Unit	Description	Duration (Hours)
1.	**Review of Digital Instrumentation** Representation of analog signals in the digital domain – Review of quantization in amplitude and time axes, sample and hold, sampling theorem, ADC and DAC.	06
2	**Fundamentals of Virtual Instrumentation (VI):** Concept of virtual instrumentation – PC based data acquisition – Typical on board DAQ card – Resolution and sampling frequency - Multiplexing of analog inputs – Single-ended and differential inputs – Different strategies for sampling of multi-channel analog inputs. Concept of universal DAQ card - Use of timer-counter and analog	10

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	outputs on the universal DAQ card.	
3	**Cluster of Instruments in VI SYSTEM** Interfacing of external instruments to a PC – RS232, RS 422, RS 485 and USB standards - IEEE 488 standard – ISO-OSI model for serial bus – Introduction to bus protocols of MOD bus and CAN bus.	**10**
4	Graphical Programming environment in VI Concepts of graphical programming – Lab-view software – Concept of VIs and sub VI - Display types – Digital – Analog – Chart – Oscilloscopic types – Loops – Case and sequence structures - Types of data – Arrays – Formulae nodes –Local and global variables – String and file I/O.	**10**
5	Analysis Tools and Simple Applications in VI Fourier transform - Power spectrum - Correlation – Windowing and filtering tools – Simple temperature indicator – ON/OFF controller – P-I-D controller - CRO emulation - Simulation of a simple second order system – Generation of HTML page.	**09**
	Total	**45 Hours**

Text Books:

1. Jerome Jovitha**,** Virtual Instrumentation Using Labview, Paperback, 2010
2. S. Gupta and J.P Gupta, 'PC Interfacing for Data Acquisition and Process Control', Instrument society of America, 1994.

Reference Books:

1. 1. Kevin James, 'PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control', Newness, 2000.
2. Gary W. Johnson, Richard Jennings, 'Lab-view Graphical Programming', McGraw Hill Professional Publishing, 2001.

Term Work:

1. Minimum two assignments.
2. Minimum ten experiments covering the whole syllabus duly recorded and graded.
3. Two term test papers.

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Program:	**B. Tech. (Mechatronics Engineering)**			**Semester: VIII**	
Course :	(Elective IV) - Automotive Electronics			**Code:** BTMA08008	
Teaching Scheme				**Evaluation Scheme**	
Lecture Hours per week	**Practical Hours per week**	**Tutorial Hours per week**	**Credit**	**Internal Continuous Assessment (ICA) As per Institute Norms (Marks – 50)**	**Theory (3 Hrs., 70 Marks)**
3	2	0	4	Scaled to 30 marks	Scaled to 70 marks

Pre-requisite: Automobile Engineering (BTMA07006), Digital Electronics (BTMA03004), Basic Control Systems (BTMA05006) and Instrumentation (BTMA05004)

Objectives:

1. To understand electrical components used in a vehicle
2. To study the application of Embedded system in automotive
3. To understand the basics and different types of control system required for the Automotive vehicle for improvement of performance of vehicle

Outcomes:

After the successful completion of this course the student will be able to

1. Analyse details of various Automotive Electrical and Electronic Systems like Batteries, Starting System, charging System, Ignition System, Lighting System and Dash – Board Instruments, Electronic ignition system, various sensors and the role of ECU
2. Suggest control system required for the Automotive vehicle for improvement of performance of vehicle.
3. Apply embedded system concepts and how it is being used in automotive vehicles.

Detailed Syllabus:

Unit	**Description**	**Duration (Hours)**
1.	**Storage Battery:** Principle of lead acid cells, plates and their characteristics containers and separators, electrolyte and their preparation, effect of temperature on electrolyte, its specific gravity, capacity and efficiency, methods of charging from D.C. mains, defects and remedies of batteries, care of idle and new batteries. Recycling Process - Recent development in batteries	**08**
2.	**Charging and Lighting System** D.C. Generators and Alternators their Characteristics. Control cutout, Electrical, Electro-mechanical and electronic regulators. Regulations for charging. Wiring Requirements, Insulated and earth return system, details of head light and side light, LED lighting system, head light dazzling and	**08**

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	preventive methods. Static and Dynamic Bending lights. Starter Motor & Drives: Battery motor starting system, condition at starting, behavior of starter during starting series motor and its characteristics, consideration affecting size of motor, types of drives, starting circuit.	
3.	**Ignition systems and Engine Management Systems:** Ignition fundamentals, Types of solid state ignition systems, components, construction And operating parameters, high energy ignition distributors, Electronic spark timing, Ignition Advance, Types DIS, MBT and control. Combined ignition and fuel management systems. Exhaust emission control, Digital control techniques – Dwell angle calculation, Ignition timing calculation and Injection duration calculation. Complete vehicle control systems, Artificial intelligence and engine management	**08**
4.	**Chassis Electrical systems:** Antilock brakes (ABS), Types, Active suspension, Traction control, Electronic control of automatic transmission, other chassis electrical systems, Central locking, Air bags and seat belt tensioners. Microprocessor And Microcomputer controlled devices in automobiles such as instrument cluster, Voice warning system, Travel information system, GPS, AUTOCOP , Keyless entry system	**08**
5.	**Electronic Accessories: Warning and alarm instruments:** Brake actuation warning system, trafficators, flash system, oil pressure warning system, and engine over heat warning system, air pressure warning system, speed warning system, door lock indicators, neutral gear indicator, horn design, permanent magnet horn, air & music horns. Wind shield wiper. Window washer, instrument wiring system and electromagnetic interference suppression, wiring circuits for instruments, electronic instruments, dash board illumination and MIL.	**08**
6.	**Integration of Software and Hardware:** Downloading the Software from Host Machine to Target Machine. Implementing application prototype: Power Window and Automotive Lighting System	**05**
	Total	**45 Hours**

Text Books:

1. Hillier, "Fundamentals of Automotive Electronics", Sixth edition, Oxford, 2010
2. Kohli P L., "Automotive Electrical Equipment", Tata McGraw Hill Publishing Co., Delhi, 2004.
3. William B. Ribbens -Understanding Automotive Electronics, 5th edition- Butter worth Heinemann, 1998

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Reference Books:

1. Tom Denton "Automotive Electrical and Electronics"-SAE, 2000 2. Judge AW
2. Bosch, "Automotive Hand Book", 8th edition, SAE, 2007
3. U. Kiencke, and L. Nielsen,"Automotive Control Systems", SAE and Springer-Verlag, 2000
4. Ljubo Vlacic, Michel Parent & Furnio Harshima, "Intelligent Vehicle Technologies: Theory and Applications", Butterworth-Heinemann publications, 2001.

Term Work:

1. Minimum two assignments.
2. Minimum ten tutorials based on the whole syllabus duly recorded and graded.
3. Two term test papers.

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Program: B. Tech. (Mechatronics Engineering)				**Semester: VIII**	
Course : (Elective IV) - Artificial Intelligence				**Code:** BTMA08009	
Teaching Scheme				**Evaluation Scheme**	
Lecture Hours per week	**Practical Hours per week**	**Tutorial Hours per week**	**Credit**	**Internal Continuous Assessment (ICA) As per Institute Norms (Marks – 50)**	**Theory (3 Hrs., 70 Marks)**
3	2	0	4	Scaled to 30 marks	Scaled to 70 marks

Pre-requisite: Basic Control Systems (BTMA05006), Computer Programming I & II (BTAB01006), (BTAB02005)

Objectives:

1. To understand complex control systems.
2. To study the implementation principles of intelligent systems.
3. To design and implement fuzzy logic and neural network in simple systems

Outcomes:

After the successful completion of this course the student will be able to

1. Analyse intelligent system using AI techniques.
2. Suggest suitable AI solution in system design.
3. Analyse ANN and Fuzzy system implementation.

Detailed Syllabus:

Unit	Description	Duration (Hours)
1.	**Artificial Intelligence:** Overview, significance and role of AI. Overview of application of Artificial Intelligence. Scope and History of AI. Typical AI Problems, AI Techniques.	**08**
2.	**AI Components, Languages and Strategies:** Definition and Importance of Knowledge, Components of Knowledge, Knowledge Based System, Knowledge representation, Organization, Manipulation and Acquisition. Strategies for Knowledge Acquisition, Knowledge Representation Languages, Issues in Knowledge Representation. A Network Representation Language.	**08**
3.	**Automated Reasoning:** The General Problem Solver and Difference Tables. Resolution Theorem Proving. Machine Learning. Perceptron Learning, Back Propagation Learning, Competitive Learning.	**05**
4.	**Knowledge Based Design Aids:** Inference Process, Backward Chaining, Forward Chaining, Hybrid	**05**

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	Chaining. Feature Based Modelling, Feature Recognition, Design by Features. Application of Feature Based Models.	
5.	**Introduction to Neural Network** Fundamental Concepts and Models, Learning Process, Learning Rules, Single Layer Perceptron Classifier, Multilayer Feedforward Network, Single-Layer Feedback Networks. Hamming Net and MAXNET, Unsupervised Learning of Clusters, Counter propagation Network, Feature Mapping, Self-Organizing Feature Maps. Cluster Discovery Network.	**08**
6.	**Introduction to Fuzzy logic** Introduction, Fuzzy Sets, Fuzzy relations, Operations on Fuzzy Relations, Membership Functions, Fuzzification and Defuzzification, Logic and Fuzzy System, Fuzzy Arithmetic, The Extension Principle, Fuzzy Associative Memories.	**08**
7.	Fuzzy System and Applications Decision making with Fuzzy Information, Fuzzy Classification and Pattern Recognition, Fuzzy Control System, Fuzzy Optimization. Fuzzy-neural applications examples.	**03**
	Total	**45 Hours**

Text Books:

1. Timothy Ross, Fuzzy Logic with Engineering Application, Wiley, 3rd edition, 2011.
2. Introduction to Artificial Intelligence and Expert System. DAN. W. Patterson, 2002, PHI/Pearson.
3. Artificial Intelligence, Fifth Edition -George.F.Luger 2008. Pearson Education, Asia.
4. Introduction to Artificial Neural networks by Jacek M. Zurada 1992.

Reference Books:

1. Introduction to Artificial Neural networks by Simon Haykin, Neural Networks, PHI, 3rd edition, 2010.
2. D. Driankov, H. Helendoorn, M. Reinfrank, An Introduction to Fuzzy Control , Narosa, 1st edition, 2001.
3. S. Rajasekaran, G. A. Vijaylakshmi Pai, Neural Network, Fuzzy Logic & Genetic Algorithms Synthesis & Application, PHI, 1st edition, 2009.

Term Work:

1. Minimum two assignments.
2. Minimum ten tutorials based on the whole syllabus duly recorded and graded.
3. Two term test papers.

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