UNIVERSITY OF PUNE

Structure and Syllabus

FOR

M.E. Mechanical Engineering (Mechatronics) 2017-Course

UNDER FACULTY OF ENGINEERING

EFFECTIVE FROM July 2017

M.E. Mechanical Engineering (Mechatronics) – (2017 Course)

SEMESTER I

CODE	SUBJECT	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
		Lect. / Pr	Paper		TW	Oral/ Presentation	Total	
			In Sem. Assessment	End Sem. Assessment				
502801	System Modelling, Identification and Simulation	4	50	50	-	-	100	4
502802	Control Systems – I	4	50	50	-	-	100	4
502803	Sensors, Transducers and Interfacing Techniques	4	50	50	-	-	100	4
502104	Research Methodology	4	50	50	-	-	100	4
502805	Elective I**	5	50	50	-	-	100	5
502806	Lab Practice I	4			50	50	100	4
Total		**25**	**250**	**250**	**50**	**50**	**600**	**25**

SEMESTER II

CODE	SUBJECT	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
		Lect./ Pr	Paper		TW	Oral/ Presentation	Total	
			In Sem. Assessment	End Sem. Assessment				
502807	PLC Programming	4	50	50	-	-	100	4
502808	Control Systems II	4	50	50	-	-	100	4
502809	Industrial Drives & Actuators	4	50	50	-	-	100	4
502810	Elective II	5	50	50	-	-	100	5
502811	Lab Practice II	4	-	-	50	50	100	4
502812	Seminar I	4	-	-	50	50	100	4
Total		**25**	**200**	**200**	**100**	**100**	**600**	**25**

Elective I: Common to All M.E. Mechanical Specializations.**

SEMESTER III

CODE	SUBJECT	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
		Lect. / Pr	Paper		TW	Oral/ Presentation	Total	
			In Sem. Assessment	End Sem. Assessment				
602813	Microcontroller Applications in Embedded Systems	4	50	50	-	-	100	4
602814	Flexible Manufacturing Systems	4	50	50	-	-	100	4
602815	Elective III	5	50	50	-	-	100	5
602816	Seminar II	4	-	-	50	50	100	4
602817	Project Stage I	8	-	-	50	50	100	8
Total		**25**	**150**	**150**	**100**	**100**	**500**	**25**

SEMESTER IV

CODE	SUBJECT	TEACHING SCHEME	EXAMINATION SCHEME				CREDITS
		Lect. / Pr	Paper	TW	Oral/ Presentation	Total	
602818	Seminar III	5	-	50	50	100	5
602819	Project Work Stage II	20	-	150	50	200	20
Total		**25**	**-**	**200**	**100**	**300**	**25**

Lab Practice I & II:

The laboratory work will be based on completion of assignments confined to the courses of that semester.

SEMINAR:

The student shall deliver the seminar on a topic approved by authorities.

Seminar I: shall be on state of the art topic of student's own choice approved by authority. The student shall submit the seminar report in standard format, duly certified for satisfactory completion of the work by the concerned Guide and head of the department/institute.

Seminar II: shall be on the topic relevant to latest trends in the field of concerned branch, preferably on the topic of specialization based on the electives selected by him/her approved by authority. The student shall submit the seminar report in standard format, duly certified for satisfactory completion of the work by the concerned Guide and head of the department/institute.

Seminar III: shall be extension of **seminar II.** The student shall submit the seminar report in standard format, duly certified for satisfactory completion of the work by the concerned Guide and head of the department/institute.

PROJECT WORK:

The project work shall be based on the knowledge acquired by the student during the coursework and preferably it should meet and contribute towards the needs of the society. The project aims to provide an opportunity of designing and building complete system or subsystems based on area where the student likes to acquire specialized skills.

Project Work Stage – I

Project work Stage – I is the integral part of the project Work. In this, the student shall complete the partial work of the Project that will consist of problem statement, literature review, project overview, scheme of implementation (UML/ERD/block diagram/ PERT chart, etc.) and Layout & Design of the Set-up. The candidate shall deliver a presentation as a part of the progress report of Project work Stage-I, on the advancement in Technology pertaining to the selected dissertation topic.

The student shall submit the progress report of Project work Stage-I in standard format duly certified for satisfactory completion of the work by the concerned guide and head of the department/Institute.

Project Work Stage - II

In Project Work Stage – II, the student shall complete the balance part of the Project that will consist of fabrication of set up required for the project, conducting experiments and taking results, analysis & validation of results and conclusions.

The student shall prepare the final report of Project work in standard format duly certified for satisfactory completion of the work by the concerned guide and head of the department/Institute.

Note: Institute must submit the list of candidates, guide and project details (title, area, problem definition, and abstract - clearly indicating objectives and scope, sponsorship details, if any) to the university within month of commencement of third semester. The guide must be approved/qualified teacher of the institute. A guide can guide at the most 8 students per year.

Semester – I

System Modelling, Identification and Simulation [502801]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502801	4	50	50	-	-	100	4

1. **Modeling in Time and Frequency Domain** - EOM of Mechanical, Electrical, Thermal, Hydraulic (as well as coupled) system using Force/Torque Balance, EOM of Mechanical System using Lagrangian Mechanics, Transfer Function Modeling, State Space Modeling, Model Representation using Block Diagram and Signal Flow Graphs
2. **Advanced Modeling** - Linearization of non-linear System using Graphical Approach, Taylor's Series & Jacobian Approach, Modeling of MDOF system (Eigen Value, Eigen Vector, Similarity Transformation, Diagonal and Jordan Canonical Form), Modeling of Distributed Parameter System (Example system: Cantilever Beam)
3. **Bond Graph Modeling -** Introduction to Bond Graph, Power variables, Junction elements, Bond Graph standard elements, Guidelines for creating Bond Graph, Bond Graph Model of Mechanical Systems, Bond Graph model of Electrical circuit, Example models: Electric Motor, Motorbike Suspension, Single Cylinder Engine
4. **Parametric Identification** - Signal selection for identification, Black Box Identification, Least Square identification of 1^{st} and 2^{nd} order systems, ARX model and their identification using least squares
5. **Non-parametric identification** - Experimental determination of frequency response, Time domain and frequency domain identification
6. **Kalman Filter** - Introduction, Linear Kalman Filter, Extended Kalman Filter, Unscented Kalman Filter, Particle Filter, Example of State Estimation and Parameter Estimation using Kalman Filter, Error in Identification
7. Neural Networks, Artificial Neural Networks, Supervised and Un-Supervised Learning, Basic Learning Laws, Fuzzy Logic, Membership Functions, Fuzzy If-Then Rules, De-Fuzzification Techniques

Reference Books:

1. Dorf and Bishop, *"Modern Control Systems"*, 12^{th} Edition, Prentice Hall Publication**(Topic I & II)**
2. Mukherjee and Karmarkar, "*Modelling And Simulation of Engineering Systems Through Bond graphs*", Alpha Science Intranet Publisher, 2000**(Topic III)**
3. P. P. J. van den Bosch and A. C. van der Klauw, "*Modeling, Identification and Simulation of Dynamical Systems*", CRC Press, 1994 **Topic IV**
4. Simon Haykin (Ed),"*Kalman Filter and Neural Networks*", John Wiley & Sons Publication, 2001**(Topic V)**

5. H. Tsoukalas and Robert Uhrig, "*Fuzzy & Neural Approach in Engineering*", John Wiley & Sons**(Topic V & VI)**

Semester - I

Control Systems – I [502802]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502802	4	50	50	-	-	100	4

1. Introduction to Control System, Open Loop Control, Closed Loop Control, Review of State Space modelling, State Transition Matrix, Solution to State Equation, Poles, Zeros, Response of first order and second order system, Relation between Pole location and system response, Time domain specifications, Steady state error
2. Introduction to Stability, Lyapunov Criterion, Routh Hurwitz Criterion, Controllability, Observability, Determination of Controllability & Observability from Block Diagram of system, Condition Number, Effect of Condition Number on Controllability & Observability of system
3. Introduction to Full State Feedback (FSF) Control, FSF using Pole Placement, Transformation of State Space model into Control Canonical Form, Pole Placement for system in Control Canonical Form, Pole Placement using Ackermann's Formula, Linear Quadratic Regulator type Optimal Control
4. Introduction to Linear Observer (Estimator), Open Loop & Closed Loop block diagram of Observer, Design of Observer using Pole Placement, Transformation of State Space model into Observer Canonical Form, Pole Placement for system in Observer Canonical Form, Pole Placement using Ackermann's Formula, Observer / Controller Duality
5. Design of Reduced Order Observer using Pole Placement, Introduction to Compensator, Block diagram of controlled system (System + Compensator), Block diagram of controlled system (System + Reduced Order Compensator), Governing equations of controlled system, Poles of controlled system using Separation Principle
6. Design of Regulated system, Governing equations for Regulated system, Design of Command Tracking system (Integral Control with FSF), Design of Command Tracking system (Integral Control with FSF and Observer)

Important Note: Only First and Second Order Systems to be considered.

Reference Books:

1. Dorf and Bishop, "*Modern Control Systems*", 12th Edition, Prentice Hall Publication
2. Norman Nise, "*Control Systems Engineering*", 6th Edition, Wiley Publication
3. Farid Golnaraghi and Benjamin Kuo, "*Automatic Control Systems*", 9th Edition, Wiley Publication
4. Franklin, Powell & Emani-Naeini, "*Feedback Control of Dynamic Systems*", 6th Edition, Prentice Hall Publication

Semester – I

Sensors, Transducers and Interfacing Techniques [502803]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502803	4	50	50	-	-	100	4

1. **Analysis of Experimental Data** - Causes and Types of Experimental Errors. Uncertainty Analysis, Statistical Analysis of Experimental Data, Probability Distributions, Norman Error Distribution, Probability Graph Paper, Chi-Square Test of Goodness of Fit, Method of Least Squares, The correlation Coefficient, Standard Deviation, Student's t-Distribution, General Considerations of Data Analysis.
2. **Basic Electrical Measurements and Sensing Devices -** Oscilloscopes, Oscillographs, Counters and Frequency Measurements, Variable Resistance transducer, Linear Variable Differential transducer, Capacitive transducers, Piezoelectric transducers, Photo conductive transducers, Hall effect transducers, Comparison of Analog and Digital Instruments.
3. **Pressure Measurements** - Dynamic Response Considerations, Diaphragm and Bellow gauge, Bridgman gauge, Pirani Thermal Conductivity gauge, Knudsen Gauge, Ionization Gauge, Alphatron gauge, Applicability of various pressure gauges.
4. **Flow Measurements** - Flow Measurement by Drag Coefficient, Hot wire and Hot film anemometers, Magnetic Flow meters, Laser Doppler Anemometer (LDA), Pressure Probes, Impact Pressure Supersonic Flow.
5. **Temperature Measurements** - Temperature measurements by electrical effects, Transient response of thermal systems, Thermocouple compensations, Thermal conductivity measurements, Viscosity Measurements, Humidity Measurements, Heat Flux Meters, pH Measurements.
6. **Strain Measurements** - Stress and Strain, Strain Measurements, Electrical Resistance Strain gauges, Measurement of Resistance Strain gauge outputs, Temperature Compensation, Rosette Strain gauge, Temperature Compensation.
7. **Data Acquisition and Processing** - The General Data Acquisition System, Signal Conditioning, Data Transmission, Analog to Digital Converters, Digital to Analog Converters, Data Storage and Display.

Reference Books

1. J. P. Holman; "*Experimental Methods for Engineers"* McGraw Hill International Editions, Mechanical Engineering Series. ISBN 0-07-113354-2
2. K. P. Ramchandran, G. K. Vijayaraghavan; "*Mechatronics-Integrated Mechanical Electronic Systems*"; Wiley India Editions; ISBN 978-81-265-1837-1
3. R. K. Rajput; "*A Text Book of Mechatronics*"; S. Chand; ISBN 81-219-2859-1

Semester – I
Research Methodology [502104]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502104	4	50	50	-	-	100	4

1. **Introduction**
   Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Criteria of Good Research

2. **Research Problem and Research Design:**

   Definition of good research problem, Feasibility study of research problem, Importance of research problem, Sources of research problem, Criteria of good research problem, Meaning of Hypothesis, Characteristics of Hypothesis, Errors in selecting a research problem, Concept & need of research design, Meaning of variable, Selection of variables

3. **Mathematical Modelling and prediction of performance:**
   Steps in Setting up a computer model to predict performance of experimental system, Validation of results, Multi-scale modelling and verifying performance of process system, Nonlinear analysis of system and asymptotic analysis, Verifying if assumptions hold true for a given apparatus setup, Plotting family of performance curves to study trends and tendencies, Sensitivity analysis.

4. **Basic instrumentation:**
   Instrumentation schemes, Static and dynamic characteristics of instruments used in experimental set up, Performance under flow or motion conditions, Data collection using a digital computer system, Linear scaling for receiver and fidelity of instrument, Role of DSP in data collection in noisy environment, Good measurement practice.

5. **Applied statistics:**

   Regression analysis, curve fitting and developing Correlation, Parameter estimation, Multivariate statistics, Principal component analysis, Moments and response curve methods, State vector machines and uncertainty analysis, Probable errors in the research, Error analysis and methods to reduce errors in research process.

6. **Research report writing and Publication**

   Research Report: Dissemination of research findings, outline and structure of research report, different steps and precautions while writing research report, methods and significance of referencing

Publishing Research work: Selection of suitable journal for publishing research work, Open access Vs Subscription Journals, Identifying indexing of selected journals, Impact factor of the journal, structure of research paper, Check for plagiarism of the article, Research paper submission and review process.

Lab Practice:

1. Write Sample research proposal of the planned research topic giving details of topic, significance, funding required etc.
2. Write a research paper on review of at least 5 research papers for a research topic (Language, formatting and authors guidelines to be strictly followed from standard Springer or Elsevier Journals and referred journal details to be mentioned in the Lab practice file) and verify the research article for plagiarism and attach the plagiarism report.

Reference Books:

1. Research methodology: an Introduction for Science & Engineering students, by Stuart Melville and Wayne Goddard
2. Research Methodology: Methods and Trends, by Dr. C. R. Kothari
3. Research Methodology: An Introduction by Wayne Goddard and Stuart Melville
4. Research Methodology: A Step by Step Guide for Beginners, by Ranjit Kumar, 2nd Edition
5. Operational Research by Dr. S.D. Sharma, Kedar Nath Ram Nath & Co.
6. Software Engineering by Pressman

Semester – I

Elective – I [502805]

[Elective I Common to All M.E. Mechanical Specializations]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502805	5	50	50	-	-	100	5

Modules of 2 Credits (Select any Two)			
Code No.	**Title**	**Code No.**	**Title**
ME2I – M1	Energy Audit and Management	ME2I – M6	Operation Management
ME2I – M2	Financial Management	ME2I – M7	Engineering Economics
ME2I – M3	Financial Costing	ME2I – M8	Technology Forecasting
ME2I – M4	Project Management	ME2I – M9	Technology Transfer
ME2I – M5	Energy Efficient Technologies in Electrical Systems	ME2I – M10	Human Rights
Modules of 1 Credit (Select any One)			
Code No.	**Title**	**Code No.**	**Title**
ME1I – M11	Environmental Pollution and Control	ME1I – M12	Intellectual property Rights

Note: For e.g., ME2I-M1 indicates
ME – Common to all M.E. Mechanical Course, 2 – 2 Credits, I – Elective I, M1 – Module 1

ME2I – M1 Energy Audit and Management

Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments

Ref. Books: Guide Books, Bureau of Energy Efficiency

ME2I – M2 Financial Management

Investment-need, Appraisal and criteria, Financial analysis techniques- Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis, Financing options, Energy performance contracting and role of Energy Service Companies (ESCOS).

Ref. Books: Guide Books, Bureau of Energy Efficiency

ME2I – M3 Financial Costing

Significance, Traditional absorption costing, Marginal costing, Contract costing, Activity based costing, Process costing

Ref. Books: Cost Accounting, N K Prasad, Book Syndicate Pvt. Ltd.

ME2I – M4 Project Management

Definition and scope of project, Technical design, Financing, Contracting, Implementation and performance monitoring. Implementation plan for top management, Planning Budget, Procurement Procedures, Construction, Measurement & Verification.

Ref. Books: Guide Books, Bureau of Energy Efficiency

ME2I – M5 Energy Efficient Technologies in Electrical Systems

Maximum demand controllers, Automatic power factor controllers, Energy efficient motors, Soft starters with energy saver, Variable speed drives, Energy efficient transformers, Electronic ballast, Occupancy sensors, Energy efficient lighting controls.

Ref. Books: Guide Books, Bureau of Energy Efficiency

ME2I – M6 Operation Management

Introduction, Importance, Operating systems models, key decisions, Planning and controlling, Strategic approach, Processes and systems, supply chain or network approach, Technology and knowledge management, Quality Management, Operations - Challenges, Opportunities, Excellence, risk management and sustainability, Case studies

Ref. Books:1) Operations Management - An Integrated Approach, Danny Samson and Prakash J. Singh, :Cambridge University Press, 2) Modern production/Operations Management, 8th Edition, E.S. Buffa and R. K. Sarin, John Wiley & Sons.

ME2I – M7 Engineering Economics

Fundamentals, Markets and Government in a Modern economy, Basic Elements of Supply and Demand, Demand and Consumer Behaviour, Analysis of Perfectly Competitive Markets, Unemployment, Inflation and Economic policy

Ref. Books: Economics, Samuelson Nordhaus, Tata McGraw Hill

ME2I – M8 Technology Forecasting

Approaches, Technology Performance Parameters, Use of Experts in Technology Forecasting, Planning, Technology Progress. Morphological Analysis of a Technology System.

Ref. Books: 1) Gerard H. Gaynor, Hand Book of Technology Management, Mc Graw Hill.

ME2I – M9 Technology Transfer

Definition, Source of Technology Transfer [TT], Model of TT with Public and Private Enterprises, Success and Failure Factors in Technology Transfer. The concepts of Invention and Innovation, Definition and classifications of Research and Development, New Product Development, Challenges in Commercializing Research Results.

Ref. Books: 1) Gerard H. Gaynor, Hand Book of Technology Management, Mc Graw Hill.

ME2I – M10 Human Rights

Human Rights – Concept, Development, Evolution, Philosophical, Sociological and Political debates, Benchmarks of Human Rights Movement. Human Rights and the Indian Constitution Human Rights & State Mechanisms, Police & Human Rights, Judiciary & Human Rights, Prisons & Human Rights, National and State Human Rights Commissions, Human Rights of the Different Sections and contemporary issues, Citizens' Role and Civil Society, Human Rights and the international scene Primary Information with reference to Engineering Industry

Ref. Books: 1)Study material on UNESCO,UNICEF web site, 2)HUMAN RIGHTS IN INDIA A MAPPING,Usha Ramanathan, 3)Introduction to International Humanitarian Law by Curtis F. J.

Doebbler - CD Publishing , 2005 .This book is an introductory text on international humanitarian law (the laws of war) that provides the basics of law, including excerpts from some of the leading treaty texts. Perfect for a short course in the law -- one to five weeks, 4) Freedom of Information by Toby Mendel - UNESCO , 2008

ME1I – M11 Environmental and Pollution control

Pollution and Environmental Ethics, Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards Environmental impact and economic aspects, Emission standards and regulations for Automobiles.

Ref. Books: 1) Environmental Pollution and Control, J. Jeffrey Peirce, P Aarne Vesilind, Ruth Weiner, Butterworth-Heinemann, 2) Environmental Pollution Control Engineering, C.S. Rao, New Age International

ME1I – M12 Intellectual property Rights

Patentable and non-patentable inventions, statutory exceptions, Persons entitled to apply for patents.

Ref. Books: 1) Satyawrat Ponkshe, The Management of Intellectual Property, by, Ponkshe & Bhate Publications, Pune.

Semester – I
Lab Practice – I [502806]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Pr/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502806	4	-	-	50	50	100	4

Lab work or Assignments have to be carried out at respective labs as mentioned in the syllabus of respective subjects excluding Research Methodology and Elective. It is to be submitted as term work at the end of semester after continuous assessment of each by respective teacher. Assessment of term work has to be carried out as per R-1.4 and R-1.5 of PG Rules and Regulations of Credit System. (Refer University web site)

List of Assignments: Students have to submit a minimum of six assignments from below list; Assignment number 8 is a compulsory assignment.

1. Matlab based assignment on Modelling and Analysis in Time and Frequency Domain: State Space and Transfer Function Modelling of MIMO/SISO System.
2. Model representation using Block Diagram and Signal Flow Graphs for multiple input and multiple output systems.
3. Bond Graph Modelling of Electrical System using 20Sim
4. Bond Graph Modelling of Mechatronics System using 20Sim
5. Bond Graph Modelling of Robotic Arm using 20Sim
6. Identification of Second Order System using Linear and Extended Kalman Filter
7. Assignment on design of Reduced Order Observer using Pole Placement, involving controlled system using Separation Principle
8. Assignment on design of Reduced Order Observer using Pole Placement, involving Block diagram of controlled System + Compensator, System + Reduced Order Compensator.
9. Assignment on Analysis of Experimental Data involving Uncertainty Analysis, Statistical Analysis, Norman Error Distribution, Probability Graph Paper, Chi-Square Test of Goodness of Fit, Student's t-Distribution

Semester - II

PLC Programming [502808]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502808	4	50	50	-	-	100	4

1. **Programmable Logic Controllers:** An Overview- Principles of Operation , PLC Vs Computers, I/O section, Discrete I/O Module, analog I/o Modules, /O Specifications, Memory types and Design, Programming Devices, Number Systems and Codes review.
2. **Basics of PLC Programming** : The logic gates, Boolean Algebra, Developing Circuits from Boolean Algebra, Hardwired Vs Programmable Logic, Programming word level logic instructions, Program Scan, Relay Type instructions, Instruction addressing, Branch Instruction, programming Ex if closed and Examine if Open instructions, Entering the ladder program.
3. **PLC wiring diagrams and Logic Programs**: Electro-magnatic Control Relays, Contactors, Motor Starters, Manually operated switches, mechanically operated Switches, Transducers and Sensors, Output Control devices; Seal in circuits, latching relays converting relay schematics into ladder logic.
4. **Programming Counters and Timers** : Mechanical Timing Relay, Timer instruction, On delay timer instruction, Off delay timer instruction, retentive timer, cascading timer, Counter Instructions, Up counter, down counter, cascading counters, incremental Encoder Counter applications, combining timer and counter instructions.
5. **Program Control and Data Manipulation Instructions**: Master control reset instruction, Jump instructions and subroutines, Immediate input and immediate output instructions, Forcing External I/o address, Safety circuitry, Selectable timed interrupt, Fault routing temporary end instructions. Data Manipulation, Data Transfer Operations, Data Compare Instructions, Data manipulation programs, Numerical data I/o interfaces, Set point control.
6. **Math, Sequencer and Shift register Instruction** : Math instruction, Addition Instruction, Subtraction Instruction, multiplication Instruction, Division Instruction, Other word level Math Instructions, File arithmetic operations, Mechanical Sequencers, Sequencer Instructions, Sequencer Programs, Shift Registers, Word Shift Registers, PLC Program editing, Programming and Monitoring, Preventive Maintenance, Troubleshooting.

Reference Book: Frank D Petruzella; “Programmable Logic Controllers”; McGraw Hill Publishing, 3/e

Semester - II

Control Systems-II [502808]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502808	4	50	50	-	-	100	4

1. **Process Models:** Recap of Modelling in Frequency domain (Transfer Function), Algebraic Systems, Static models, Dynamic models (Integrator, Integrator with Time Delay, First Order, First Order with Time Delay, Second Order, Second Order with Time Delay), Identification using the Time domain
2. **Frequency Domain & Stability:** Introduction of Frequency domain, Plotting frequency response function (Bode Plots, Nyquist Plots & Nichols Charts), Gain, Phase & Delay Margins, Root-Locus, The Cauchy Criterion, Nyquist Stability Criterion, Effect of time delays on stability
3. **Relation between open and closed loop frequency response:** M and N Circles, Maximum amplitude of closed-loop response, Resonance frequency, Bandwidth, PID Control: Recap of PID Control, Series and Parallel form of PID, Role of P, I & D element, Actuator saturation and integral windup, Realization of PID control
4. **PID Tuning:** Feature based techniques (Ziegler-Nichols (Step Response, Ultimate Gain, & Generalized method), Chien, Hrones and Reswick Step Response Method, Cohen-Coon Method), Techniques based on analytical model (Pole Placement, Dominant Pole, Cancellation of Process Pole)
5. **Sensitivity Relationship:** Sensitivity function, Complementary sensitivity function, Sensitivity of open loop and closed loop, Loop shaping, Relationship between sensitivity and gain and phase margin, Robust stability criterion and control specifications
6. **Advanced Tuning Techniques:** Need for Advanced Tuning, Kappa Tau (KT) Tuning, Design of ITAE Optimal System, Design of Internal Model Controller

Important Note: Only First and Second Order Systems to be considered.

Reference Books :

1. Dorf and Bishop; "*Modern Control Systems*", 12/e; Prentice Hall Publication
2. Norman Nise "*Control Systems Engineering*"; 6/e Edition, Wiley Publication
3. Astrom & Hagglund, "*PID Controllers: Theory, Design and Tuning*"; The Instrumentation, Systems, and Automation Society

Semester - II
Industrial Drives and Actuators [502809]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502809	4	50	50	-	-	100	4

1. **DC Motor Drives –** Introduction criteria for selecting drive components, Equivalent Circuit of dc Motors, Permanent Magnet dc Motor, dc motor with separately excited field winding; Effect of armature current waveforms, dc servo drives, Adjustable Speed dc Drives;
2. **Induction Motor Drives** Introduction, Basic principles of induction motor operation, induction motor characteristics at rated frequency and rated voltage, Speed control by varying stator frequency and voltage, Impact of Non-sinusoidal excitation on Induction Motors, Variable Frequency converter classifications, Variable frequency PWM VSI Drives, Variable frequency square wave VSI drives, Variable frequency CSI drives, Comparison of variable frequency drives, Line frequency variable voltage drives, Reduced voltage starting of induction motors, speed control by static slip power recovery.
3. **Synchronous Motor Drives –** Introduction, Basic Principles of synchronous motor operation, Synchronous servomotor drives with sinusoidal waveforms, Synchronous Servomotor Drives with Trapezoidal waveforms, Load commutated inverter drives, Cyclo-converters.
4. **Basic Hydraulics** - Types, classification, principle of working and constructional details of vane pumps, gear pumps, selection of pumps for hydraulic power transmission. Symbols for hydraulic circuits. Necessity of fluid control through pressure control, directional control, flow control valves. Principle of pressure control valves, direct operated and pilot operated relief valves, pressure reducing valve, sequence valve. Principle of flow control valves, pressure compensated, temperature compensated flow control valves, flow through restrictor. Types of directional control valves,
5. **Actuators** - Linear and Rotary, Hydraulic motors- Types- Vane, gear, piston types, radial piston. Methods of control of acceleration, deceleration, Types of cylinders and mountings, Calculation of piston velocity, thrust under static and dynamic applications, considering friction, inertia loads, Design considerations for cylinders.
6. **Industrial circuits** - Simple reciprocating, Regenerative, Speed control(Meter in, meter out & bleed off), Sequencing, Synchronization, transverse & feed, circuit for riveting machine, automatic reciprocating, fail safe circuit, counter balance circuit, actuator locking, circuit for hydraulic press, unloading circuit.

Reference Books:

1. Mohan, Undeland, Riobbins; "*Power Electronics*" Wiley India Pvt. Ltd., ISBN 978-81-265-1090-0
2. Pinches; '*Industrial Fluid Power'*, Prentice hall
3. D.A.Pease – '*Basic Fluid Power'*, Prentice hall
4. J.J.Pipenger – '*Industrial Hydraulics'*, McGraw Hill
5. H.L.Stewart – '*Hydraulics and Pneumatics'*, Industrial Press

6. A. Esposito – '*Fluid Power with application'*, Prentice hall
7. B. Lall – '*Oil Hydraulics'*, International Literature Association
8. Yeaple – '*Fluid Power Design Handbook'*

Semester – II

Elective – II [502810]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502810	5	50	50	-	-	100	5

Modules of 2 Credits (Select any Two)			
Code No.	**Title**	**Code No.**	**Title**
Code	**Title(Non Circuit Branches)**	**Code**	**Title (Circuit Branches)**
MT2II-M1	Transistor Amplifiers	**MT2II-M7**	Theory of Machines-II
MT2II-M2	Operational Amplifiers	**MT2II-M8**	Theory of Machines-III
MT2II-M3	Digital Principles and Logic Design – I	**MT2II-M9**	Internal Combustion Engines-II
MT2II-M4	Digital Principles and Logic Design – II	**MT2II-M10**	Internal Combustion Engines-III
MT2II-M5	Generic Power Electronic Circuits	**MT2II-M11**	Kinetics of Particles
MT2II-M6	Semiconductor Devices	**MT2II-M12**	Plane motion of rigid bodies
Modules of 1 Credit (Select any One)			
Code No.	**Title**	**Code No.**	**Title**
Code	**Title(Non Circuit Branches)**	**Code**	**Title (Circuit Branches)**
MT1II-M13	Fully Differential Operational Amplifiers	**MT1II-M16**	Friction, Moments of Inertia, Virtual Work
MT1II-M14	Digital Principles and Logic Design – III	**MT1II-M17**	Internal Combustion Engines-I
MT1II-M15	Synchronous Sequential Machines	**MT1II-M18**	Theory of Machine-I

Note: For e.g., MT2II-M1 indicates
MT – Mechatronics, 2 – 2 Credits, II – Elective II, M1 – Module 1
For e.g., MT1II-M15 indicates
MT – Mechatronics, 1 – 1 Credit, II – Elective II, M15 – Module 15

MT2II-M1 : Transistor Amplifiers

Bipolar**,** MOS, and BiMOS Integrated Circuit Technology; Single Transistor and Multiple Transistor Amplifiers; Current Mirrors, Active loads, and References; Output stages;

Reference Book : Gray, Hurst, Lewis, Meyer; "*Analysis and Design of Analog Integrated Circuits*"; Wiley India Pvt. Ltd. ISBN 978-81-5-265-2148-7

MT2II-M2 : Operational Amplifiers

Operational Amplifiers with single ended outputs; Frequency response of Integrated Circuits; Feedback; Frequency Response and Stability of Feedback Amplifiers; Noise in Integrated Circuits.

Reference Book : Gray, Hurst, Lewis, Meyer; "*Analysis and Design of Analog Integrated Circuits*"; Wiley India Pvt. Ltd. ISBN 978-81-5-265-2148-7

MT2II-M3 : Digital Principles and Logic Design-I

Digital Principles; Digital Logic; Combinational Logic Circuits; Data Processing Circuits;

Reference Book : Leach, Malvino, Saha; "*Digital Principles and Applications*"; McGraw Hill Publishing --Company; ISBN -0-07-014170-3

MT2II-M4 : Digital Principles and Logic Design - II

Number Systems and Codes; Arithmatic Circuits; Clocks and timing Circuits; Flip-Flops; Registers

Reference Book : Leach, Malvino, Saha; "*Digital Principles and Applications*"; McGraw Hill Publishing --Company; ISBN -0-07-014170-3

MT2II-M5 : Generic Power Electronics Circuits

Line-Frequency Phase Controlled Rectifiers and Inverters; dc-dc Switch Mode Converters; Switch Mode dc-ac Inverters; Resonant Converters;

Reference Book : Mohan, Undeland, Riobbins; "*Power Electronics*" Wiley India Pvt. Ltd., ISBN 978-81-265-1090-0

MT2II-M6 : Semiconductor Devices

Power Diodes, Bipolar Junction Transistors, Power MOSFETs, Thyristors, Gate Turn off Thyristors, Insulated Gate Bipolar Transistors, Emerging Devices and Circuits.

Reference Book : Mohan, Undeland, Riobbins; "*Power Electronics*" Wiley India Pvt. Ltd., ISBN 978-81-265-1090-0

MT2II-M7 : Theory of Machines-II

Brakes Clutches and Dynamometers Types of Brakes, Clutches and Dynamometers, with simple numerical treatment

Cams Types, Nomenclature, Follower motions, Procedure for drawing Cam Profile of Radial Cam with roller follower, Cam with offset roller follower, Cam Size.

Governors Types, Centrifugal Governors, Performance of Governors

Reference Book: Sadhu Singh; "*Theory of Machines"* Pearson Education ISBN 81-7758-127-9

MT2II-M8 : Theory of Machines-III

Inertia force and Turning Moment Motion analysis of reciprocating mechanism, Inertia forces in the reciprocating engine, Equilibrium of forces in slier crank, Piston effort, Crank effort diagrams, Fluctuation of Energy, Flywheel with simple numerical analysis.

Gear Trains Types Sun and Planet, Epicyclic with two inputs, compound Epicyclic gear train, Epicyclic bevell gear trains, Torques in Epicyclic gear trains

Gyroscopic and Precessional Motion Precessional motion, Gyroscopic couple of plane disc, Gyroscopic couple on an aeroplane, ship, stability of four wheeler vehicle taking a turn, Stability of two wheeler vehicle taking a turn.

Reference Book: Sadhu Singh; "*Theory of Machines"* Pearson Education ISBN 81-7758-127-9

MT2II-M9 : Internal Combustion Engines II

Carburettors and Fuel Injection in SI Engines; CI Engines: Fuel-Injection System; Two-Stroke Engines; Ignition Systems

Reference Books:

1. M. L. Mathur, R. P. Sharma; "*A Course in Internal Combustion Engines*"; Dhanpat Rai and Sons; New Delhi
2. V. Ganesan; "*Internal Combustioin Engines* "; Tata McGraw Hill Publishing Company Ltd. New Delhi.

MT2II-M10 : Internal Combustion Engines III

Performance characteristics &Testing of I.C. Engine. Indicated power, brake power, friction power, Methods to determine power and efficiencies Variables affecting performance of engine. Methods of improving engine performance.

Fuels and Emission of I.C. Engines. Alternate fuels (SI & CI engines), Air pollution due to IC engine, Engine emissions. Emission control methods for SI and CI engines, Electronic control unit, Concept of hybrid vehicles. Electrical battery pack Specification

Reference Books

3. M. L. Mathur, R. P. Sharma; "*A Course in Internal Combustion Engines*"; Dhanpat Rai and Sons; New Delhi
4. V. Ganesan; "*Internal Combustioin Engines* "; Tata McGraw Hill Publishing Company Ltd. New Delhi.

MT2II-M11 : Kinetics of Particles

Newtons Second Law of Motion; Energy and Momentum methods; System of Particles; Kinematics of rigid bodies.

Reference Book: Beer, Johnston; "*Vector Mechanics for Engineers*"; 9/e; McGraw Hill Publishing company; ISBN 0-07-070030-3

MT2II-M12: Plane Motion of Rigid Bodies

Plane Motion of Rigid Bodies – Forces and Accelerations; Plane Motion of Rigid Bodies – Energy and Momentum methods; Kinetics of Rigid Bodies in Three Dimensions

Reference Book: Beer, Johnston; "*Vector Mechanics for Engineers*"; 9/e; McGraw Hill Publishing company; ISBN 0-07-070030-3

MT1II-M13 : Fully Differential Operational Amplifiers

Properties of fully Differential Amplifiers Common Mode Feedback; CMFB Circuits; Fully Differential Op Amps; Anaysis of a CMOS Fully Differential Folded-Cascode Op Amp;

Reference Book : Gray, Hurst, Lewis, Meyer; "*Analysis and Design of Analog Integrated Circuits*"; Wiley India Pvt. Ltd. ISBN 978-81-5-265-2148-7

MT1II-M14 : Digital Principles and Logic Design - III

Design of Asynchronous and Asynchronous Sequential Circuits; D/A Conversion and A/D Conversion; Memory; Digital Integrated Circuits; Applications.

Reference Book : Leach, Malvino, Saha; "*Digital Principles and Applications*"; McGraw Hill Publishing --Company; ISBN -0-07-014170-3

MT1II-M15 : Synchroneous Sequential Machines

Basic Concepts, State Assignments, General Design procedure, State Equivalence and machine minimization, machines with Finite Memory spans, Synchronous counters, Algorithmic State machines, Asynchronous inputs.

Reference Book : Norman Balabanian, Bradley Carlson; "*Digital Logic Design Principles*", Wiley India Pvt. Ltd. ISBN 978-81-265-1258-4

MT1II-M16 : Friction, Moments of Inertia, Virtual Work

Friction – The laws of dry friction, Angle of Friction, Square threaded screws, Journal Bearings, Axel Friction, Rolling friction

Moments of Inertia of Area – Second moment of an Area, Determination by integration, Polar moment of area, parallel axis theorem, product of inertias.

Moments of Inertia of Mass - Moment of Inertia of a Mass, Parallel axis theorem, Determination of M. I. of three dimensional body by integration; Ellipsoid of Inertia, Principal axes of Inertia;

Virtual work – Work of a force; Principle of Virtual Work; Applications of the Principle of virtual works.

Reference Book: Beer, Johnston; "Vector Mechanics for Engineers"; 9/e; McGraw Hill Publishing Company; ISBN 0-07-070030-3

MT1II-M17 : Internal Combustion Engines-I

Air standard cycles and fuel-air cycles : Assumptions, Otto, Diesel & Dual cycles, comparison of cycles, fuel air cycle, Valve timing diagram, Actual engine cycle.

S.I. Engines: Theory of Carburetion, Types of carburettors. Electronic fuel injection system. Stages of combustion. Phenomenon of Detonation in SI engines

Reference Books

1. M. L. Mathur, R. P. Sharma; "*A Course in Internal Combustion Engines*"; Dhanpat Rai and Sons; New Delhi
2. V. Ganesan; "*Internal Combustioin Engines* "; Tata McGraw Hill Publishing Company Ltd. New Delhi.

MT1II-M18: Theory of Machines-I

Mechanisms Introductions, Kinematic Pairs, Constrained Motion, Kinematic chain, Mechanism and Machines, Degrees of freedom, Four bar chain, Grashof's Law, Inversions of Mechanisms, Double slider crank chain

Kinematics Velocity diagrams, determination of link velocities, Acceleration diagrams, Coriolis acceleration, Link sliding in a swivelling pin, Klein's construction.

Lower Pairs Pentograph, Straight line motion mechanisms, Intermittent motion mechanisms, parallel linkages, Engine pressure indicators, Automobile steering gear mechanisms, Hooke's Joint Double Hooke's Joint,

Reference Book: Sadhu Singh; "*Theory of Machines"* Pearson Education ISBN 81-7758-127-9

Semester – II
Lab Practice II [502811]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Pr /Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502811	4	-	-	50	50	100	4

Lab work or Assignments have to be carried out at respective labs as mentioned in the syllabus of respective subjects excluding Elective. It is to be submitted as term work at the end of semester after continuous assessment of each by respective teacher. Assessment of term work has to be carried out as per R-1.4 and R-1.5 of PG Rules and Regulations of Credit System.

List of Assignments

1. PLC Program for a discrete state process control
2. PLC Program for Conveyor
3. PLC Program involving Program Control and Data Manipulation Instructions
4. PLC Program involving Math, Sequencer and Shift register Instruction
5. Assignment based on Analysis of SISO system in Frequency Domain.
6. Assignment based on PID: involving Series and Parallel form of PID, Actuator saturation and integral windup.
7. Assignment based on PID Tuning: Ziegler-Nichols (Step Response, Ultimate Gain, & Generalized method), Chien, Hrones and Reswick Step Response Method, Cohen-Coon Method)
8. Assignment based on Hydraulic Components, Direction Control Valves, Pressure Control Valves, Flow Control Valves and Actuators
9. Assignment based on Electro Hydraulics for industrial Hydraulic Circuits like sequencing circuits, unloading circuit
10. Assignment based on PLC Hydraulics for industrial hydraulic circuits.

Seminar – I, II and III [502812, 602816, 602818]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Pr /Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502812	4	-	-	50	50	100	4
602816	4	-	-	50	50	100	4
602818	5	-	-	50	50	100	5

Assessment of Seminar has to be carried out as per R-1.4 and R-1.5 of PG Rules and Regulations of Credit System.

INSTRUCTIONS FOR SEMINAR REPORT WRITING

It is important that the procedures listed below be carefully followed by all the students of M.E. (Mechanical Engineering).

1. Prepare 3 **COPIES** of your manuscript.

2. Limit your project report to preferably

   a) 15-20 manuscript pages for Seminar I
   b) 20-25 manuscript pages for Seminar II
   c) 25-30 manuscript pages for Seminar III

3. The footer must include the following:
   Institute Name, M.E. Mechanical (Mechatronics) Times New Roman 10 pt. and centrally aligned.

4. Page number as second line of footer, Times New Roman 10 Pt, centrally aligned.

5. Print the manuscript using
   a) Letter quality computer printing.
   b) The main part of manuscript should be Times New Roman 12 pt. and justified**.**
   c) Use 1.5 line spacing.
   d) Entire report shall be one chapter. No chapters for Seminar I, II and III.
   e) Seminar I shall not have last section as Conclusions, it will be summary only.

6. Use the paper size **8.5'' × 11''** or **A4 (210 × 197 mm).** Please follow the margins given below.

Margin Location	Paper 8.5'' × 11''	Paper A4 (210 × 197 mm)
Top	1''	25.4 mm
Left	1.5''	37 mm
Bottom	1.25''	32 mm
Right	1''	25.4 mm

7. All paragraphs will be 1.5 line spaced with a one blank line between each paragraph. Each paragraph will begin without any indentation.

8. Section titles should be bold with 14 pt typed in all capital letters and should be left aligned.

9. Sub-Section headings should be aligning at the left with 12 pt, bold and Title Case (the first letter of each word is to be capitalized).

10. Illustrations (charts, drawings, photographs, figures) are to be in the text. Use only illustrations really pertinent to the text. Illustrations must be sharp, clear, **black and white. Illustrations downloaded from internet are not acceptable.**
    a) Illustrations should not be more than **two** per page. One could be ideal
    b) Figure No. and Title at bottom with **12 pt**
    c) Legends below the title in **10 pt**
    d) Leave proper margin in all sides
    e) Illustrations as far as possible should not be Xeroxed.

11. **Photographs** if any should be of glossy prints

12. Please use **SI** system of units. If students would like to add the equivalent in inch-pound (British) units, they must be stated in parenthesis after the **SI** units. In case the final result comes out in any other units (say due to empirical formula etc.) covert the unit to **SI** unit.

13. Please **number the pages** on the front side, centrally below the footer

14. **References** should be either in order as they appear in the thesis or in alphabetical order by last name of first author

15. **Symbols** and **notations** if any should be included in nomenclature section only

16. Following will be the order of report

    i. **Cover page** and **Front page** as per the specimen on separate sheet
    ii. **Certificate** from the Institute as per the specimen on separate sheet
    iii. **Acknowledgement**
    iv. **List of Figures**
    v. **List of Tables**
    vi. **Nomenclature**
    vii. **Contents**
    viii. **Abstract** (A brief abstract of the report not more than **150 words**. The heading of abstract i.e. word "Abstract" should be **bold, Times New Roman, 12 pt** and should be typed at the **centre.** The contents of abstract should be typed on new line without space between heading and contents. Try to include one or two sentences each on **motive, method, key-results** and **conclusions** in the Abstract)
    ix. Section: Introduction
    x. References

17. All section headings and subheadings should be numbered. For sections use numbers **1, 2, 3, ….** and for subheadings **1.1**, **1.2**, **….** etc and section subheadings **2.1.1**, **2.1.2, ….** etc.

18. **References** should be given in the body of the text and well spread. No verbatim copy or excessive text from only one or two references. If **figures** and **tables** are taken from any reference then indicate source of it. Please follow the following procedure for references

Reference Books
Collier, G. J. and Thome, J. R., Convective boiling and condensation, 3rd ed., Oxford University Press, UK, 1996, pp. 110 – 112.

Papers from Journal or Transactions
Jung, D. S. and Radermacher, R., Transport properties and surface tension of pure and mixed refrigerants, *ASHRAE Trans*, 1991, 97 (1), pp. 90 – 98.

Bansal, P. K., Rupasinghe, A. S. and Jain, A. S., An empirical correction for sizing capillary tubes, *Int. Journal of Refrigeration*, 1996, 19 (8), pp.497 – 505.

Papers from Conference Proceedings
Colbourne, D. and Ritter, T. J., *Quantitative assessment of flammable refrigerants in room air conditioners*, Proc. of the Sixteenth International Compressor Engineering Conference and Ninth International Refrigeration and Air Conditioning Conference, Purdue University, West Lafayette, Indiana, USA, 2002, pp. 34 – 40.

Reports, Handbooks etc.
United Nations Environmental Programme, Report of the Refrigeration, Air Conditioning and Heat Pumps, Technical Option Committee, 2002, Assessment - 2002.

ASHRAE Handbook: Refrigeration, 1994 (Chapter 44)

Patent
Patent no, Country (in parenthesis), date of application, title, year.

Internet
www.(Site) [Give full length URL]

Format for front page and Certificate

A Seminar I / II / III on (TNR, 16pt, centrally aligned)

Title (TNR, 27pt, Bold, Centrally Aligned, Title Case)

By (TNR, 16pt, Centrally Aligned)

Mr. Student's Name (TNR, 16pt, Centrally Aligned)

Guide (TNR, 16pt, Centrally Aligned)

Guide's Name (TNR, 16pt, Centrally Aligned)

Institute

Logo

Department of Mechanical Engineering

Name of the Institute

[2013-14](TNR, 22pt, Title Case Centrally Aligned)

Name of the Institute

Institute

Logo

C E R T I F I C A T E

This is to certify that *Mr. Lele M.M.*, has successfully completed the seminar-I/II/III entitled "Performance analysis of……." under my supervision, in the partial fulfilment of Master of Engineering - Mechanical Engineering (Mechatronics) of University of Pune.

Date :

Place :

Guide's Name
Guide

_____
Head
Department and
Institute Name

External Examiner

Seal

_____
Principal,
Institute Name

Semester - III

Microcontroller Applications in Embedded Systems [602813]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
602813	4	50	50	-	-	100	4

1. **Microcontrollers Fundamentals –** Architecture PIC18F Family, Data transfer processes, Support Devices, PIC18F instructions and assembly language, Instruction set, Instruction Format,
2. **Instructions of PIC18F Microcontrollers** – Approach to Programming and problem solving, Integrated Development Environment. Data Copy and Set/Clear operations, Branch and Skip Operation, Generating time delays, Logic operations, Bit operations, Multiple and divide operations.
3. **Programming and interfacing –** Stack, Subroutine, Macros and Software Stack, BCD to Binary conversion, Binary to BCD conversion, Basic concepts in I/O interfacing and PIC18 I/O ports, Interfacing output peripherals, Interfacing push buttons, interfacing LCD, interfacing matrix keyboard, interfacing seven segment display
4. **Timers & Counters –** Basic concepts of Interrupts, PIC18 interrupts, Basic concepts in Timers and Counters, PIC18 Timers, Capture, Compare and PWM modules
5. **Data Converters –** Basic concepts of Data converters PIC18F4520 Analog-to-digital converter module, Digital to Analog conversion. Basic concepts in Serial communication, EIA232 and PIC18 serial communication module, Serial peripheral interface, inter integrated circuit protocol
6. **Designing Embedded System** Features of Embedded systems, Designing Embedded System, TTMS Project design- Hardware, TTMS project design – Software.

Reference Book:

1. Ramesh Gaonkar; "*Fundamentals of Microcontrollers and Applications in Embedded Systems*"; Penram International Publishing (India) Pvt. Ltd, ISBN 8187+72297

Semester – III

Flexible Manufacturing Systems [602814]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
602814	4	50	50	-	-	100	4

1. Introduction to Manufacturing Systems : Components, Classification Scheme, Single Station Automated Cells, Applications of Single Station Automated Cells, Fundamentals of Manual Assembly Lines, Analysis of Manual Assembly Lines, Line Balancing Algorithms, Considerations in Assembly Line Design
2. Automated Production Lines : Fundamentals, Applications, Analysis of Transfer Lines, Fundamentals of Automated Assembly Lines, Cellular Manufacturing Part Classifications and Coding, Applications of Group Technology, Quantitive analysis of Cellular Manufacturing.
3. Flexible Manufacturing Systems : Introduction, Components of FMS, Applications, Benefits, FMS planning and Implementation issues, Quantitive Analysis of FMS. Fundamentals of NC Technology, Computer Numerical Control, Distributed Numerical Control, Applications of NC, NC part programming. Sample NC programs including step, groove, taper, and profile turning.
4. Quality Programs in Manufacturing : Process Variability and Process capability, Statistical Process Control, Six Sigma, Taguchi Methods in Quality Engineering, ISO 9000. Coordinate Measuring Machine, Machine Vision, Non contact, Non Optical Inspection Techniques
5. Process Planning, Computer Aided Process Planning, Concurrent Engineering and Design for Manufacturing, Advanced Manufacturing Planning, Material Requirement Planning, Capacity Planning, Shop Floor Planning, Inventory Control, Lean Production, Just in Time Production Systems, Automation

Reference Books

1. Mikell P. Groover; "Automation, Production Systems, and Computer Integrated Manufacturing"; Prentice Hall Publishing New Delhi; ISBN 978-81-203-3418-2

Semester – III
Elective – III (602815)

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
602815	5	50	50	-	-	100	5

Modules of 2 Credits (Select any Two)			
Code	**Title (Non Circuit Branches)**	**Code**	**Title (Circuit Branches)**
MT2III-M1	Fundamentals of DSP and Sampling	**MT2III-M7**	Applied Thermodynamics-I
MT2III-M2	Discrete Time Signals & Systems and Z transforms	**MT2III-M8**	Refrigeration & Air conditioning III
MT2III-M3	Networking Basics	**MT2III-M9**	Fluid Machines I
MT2III-M4	Physical Layer Technologies	**MT2III-M10**	Fluid Machines II
MT2III-M5	Local Area Networks	**MT2III-M11**	Applied Thermodynamics II
MT2III-M6	TCP/IP Networking	**MT2III-M12**	Refrigeration & Air conditioning II
Modules of 1 Credit (Select any One)			
Code	**Title (Non Circuit Branches)**	**Code**	**Title (Circuit Branches)**
MT1III-M13	Discrete Fourier Transforms and Linear Time invariant Filter Realization	**MT1III-M16**	Fluid Mechanics III
MT1III-M14	Wide Area Networks	**MT1III-M17**	Applied Thermodynamics III
MT1III-M15	Asynchronous Sequential Machines and HDL	**MT1III-M18**	Refrigeration & Air conditioning I

Note: For e.g., MT2III-M1 indicates
MT – Mechatronics, 2 – 2 Credits, III – Elective III, M1 – Module 1
For e.g., MT1III-M13 indicates
MT – Mechatronics, 1 – 1 Credit, III – Elective III, M13 – Module 13

MT2III-M1 Fundamentals of DSP and Sampling

Classification of Signals, Graph Terminology and domains, DT Signals and Sequencers, Sampling theorem, Sampling and Recovery of Analog Signals, Analytical treatment, Anti Aliasing Filter.

Refernce Book*:* Dr. Shaila D. Apte*; "Digital Signal Processing";*Wiley India Pvt., Ltd. ISBN 978-81-265-2142-5

MT2III-M2 Discrete Time Signals & Systems and Z transforms

DT representation of Sinusoids, Standard DT signals, DT signals, DT Systems, Properties of LTI systems, Need of Z transform, Properties of Z Transforms, Relation between Pole locations

and time domain behaviour, Inverse Z transforms, Solution of Difference equation using Z Transform, Application of ZT and IZT

Reference Book*:* Dr. Shaila D. Apte*; "Digital Signal Processing";*Wiley India Pvt., Ltd. ISBN 978-81-265-2142-5

MT2III-M3 Networking Basics

Evolution of Computer Networks, General Principles of Network Design, Packet and Circuit Switching, Network architecture and standardization, Examples of Networks, Network characteristics,

Reference Book: Natalia Olifer, Victor Olifer; "Computer Networks – Principles, Technologies, and Protocols for Network Design"; Wiley India Pvt. Ltd., ISBN 978-81-265-0917-1

MT2III-M4 Physical Layer Technologies

Transmission Links, Data encoding and multiplexing, Wireless transmission, Transmission Networks,

Reference Book: Natalia Olifer, Victor Olifer; "Computer Networks – Principles, Technologies, and Protocols for Network Design"; Wiley India Pvt. Ltd., ISBN 978-81-265-0917-1

MT2III-M5 Local Area Networks

Ethrnet, High speed Ethernet, Shared Media LANs, Switched LAN basics, Advanced Features of Switched LANs,

Reference Book: Natalia Olifer, Victor Olifer; "Computer Networks – Principles, Technologies, and Protocols for Network Design"; Wiley India Pvt. Ltd., ISBN 978-81-265-0917-1

MT2III-M6 TCP/IP Networking

Addressing in TCP/IP networks, Internet Protocol, Core protocol of TCP/IP stack, Advanced features of IP routers,

Reference Book: Natalia Olifer, Victor Olifer; "Computer Networks – Principles, Technologies, and Protocols for Network Design"; Wiley India Pvt. Ltd., ISBN 978-81-265-0917-1

MT2III-M7 Applied Thermodynamics-I

Laws of Thermodynamics. First Law of Thermodynamics, Second Law of Thermodynamics, Clausius statement and Kelvin-Plank statement. Perpetual Motion Machine I & II, Entropy principles

Ideal Gas Properties and Processes Ideal gas behaviour. Various processes

Reference Books:

1. P. K. Nag; "*Engineering Thermodynamics*"; McGraw Hill Education Pvt. Ltd. ; 5/e ISBN 1-25-906256-2
2. Y. V. C. Rao; "*An Introduction to Thermodynamics*"; United Press ISBN 978-81-7371-461-0

MT2III-M8 Refrigeration and Air Conditioning III

Refrigerants: properties of refrigerant, classification of refrigerant.

Multi pressure system: need of multistage system, application and thermodynamic evaluation Psychometric terms, concept of Human comfort, effective temperature , ventilation requirement

Reference Books:

1. Arora & Domkundwar; "*A Course in Refrigeration and Air Conditioning*"; dhanpat Rai and Sons, New Delhi.
2. C. P. Arora; "*Refrigeration and Air Conditioning*"; Tata McGraw Hill Publishing Ltd., New Delhi.
3. Ballaney P. L.; "*Refrigeration and Air Conditioning*"; Khanna Publishers, New Delhi. 1992

MT2III-M9 Fluid Machines-I

Introduction, Hydraulic turbines, water wheels and turbines, Radial flow turbines, Propeller and Kaplan Turbines, The Pelton wheel, and Performance of turbines.

Reference Books: S Ramamurtum; "*Hydraulics, Fluid Mechanics and Fluid Machines*"; 8/e; Dhanpatrai Publishing Company ISBN 81-87433-84-1

MT2III-M10 : Fluid Machines-II

Hydraulic Pumps; Centrifugal Pumps, Reciprocating Pumps; and Miscellaneous Pumping Devices

Reference Books: S Ramamurtum; "*Hydraulics, Fluid Mechanics and Fluid Machines*"; 8/e; Dhanpatrai Publishing Company ISBN 81-87433-84-1

MT2III-M11 Applied Thermodynamics II

Reciprocating Air Compressor, Types of compressor valves, Theoretical and actual indicator diagram.

Multistage compressors Constructional details of multistage compressors, Theoretical and actual indicator diagram for multi stage compressors,

Capacity control of compressors, **Rotary Air Compressors** : Classification

Steam Generators: Classification **Analysis of boilers:** Boiler efficiency by direct and indirect method.

Reference Books:

1. P. K. Nag; "*Engineering Thermodynamics*"; McGraw Hill Education Pvt. Ltd. ; 5/e ISBN 1-25-906256-2
2. Y. V. C. Rao; "*An Introduction to Thermodynamics*"; United Press ISBN 978-81-7371-461-0

MT2III-M12 Refrigeration and Air Conditioning-II

Refrigeration system component: working principle and classification.

Air conditioning system: layout and component. Air conditioning system component: operating and working principal. Construction and type. Duct: classification of duct. Food Preservation:control and modified atmospheric storage.

Reference Books:

1. Arora & Domkundwar; "*A Course in Refrigeration and Air Conditioning*"; dhanpat Rai and Sons, New Delhi.
2. C. P. Arora; "*Refrigeration and Air Conditioning*"; Tata McGraw Hill Publishing Ltd., New Delhi.
3. Ballaney P. L.; "*Refrigeration and Air Conditioning*"; Khanna Publishers, New Delhi. 1992

MT1III-M13 Discrete Fourier Transforms and Linear Time invariant Filter Realization

Sampling theorem in Frequency domain, Interpolation formula for F(ω), Relationship to Z Transforms, Properties of DFT, Circular convolution and its implementation, Conversion of

Linear convolution to circular convolution, Efficient computation of DFT, Linear Filtering using FFT, Goertzel Algorithm, Spectral Resolution and selection of window length, Fre3quency analysis of DT signals, Power spectral Density and Energy Spectral Density, Chirp Z Transform Algorithm, FIR and IIR systems, FIR system structures, IIR System Structures.
Reference Book*:* Dr. Shaila D. Apte*; "Digital Signal Processing";*Wiley India Pvt., Ltd. ISBN 978-81-265-2142-5

MT1III-M14 Wide Area Networks

Virtual Circuit WAN – Virtual Circuits Techniques, X.25 Networks, Frame Relay Networks, ATM technology
IP WANs – Pure IP WANS, IP over ATM or Frame Relay, Multiprotocol Label Switching, network Management
Remote access – Methods of Remote Access, DIAL Up Analog Access, Dial Up Access using ISDN, XDSL Technology, Access using cable TV, Wireless Access
Secure Transport services – IPSEC protectd channel services, Virtual private network service; MPLS VPN.
Reference Book: Natalia Olifer, Victor Olifer; "Computer Networks – Principles, Technologies, and Protocols for Network Design"; Wiley India Pvt. Ltd., ISBN 978-81-265-0917-1

MT1III-M15 Asynchronous Sequential Machines and HDL

The fundamental mode model, The flow table, Reduction of incompletely specified machines, Races and Cylces, Hazards
Design using Hardware Description Language – The Hardware Description Language ABEL, Programmable logic devices, The design Flow for HDL specifications
Reference Book : Norman balabanian, Bradley Carlson; "*Digital Logic Design Principles"*; Wiley India Pvt. Ltd ISBN 978-81-265-1258-4

MT1III- M16 Fluid Mechanics III

Properties of fluid; Buoyancy and floatation; Kinematics of Fluid Flow; Dynamics of Fluid flow- Fundamental equations of fluid flow; Dimensional and Model Analysis. Boundry layer; Forces on Immersed Bodies; Impact of Jets.
Reference Books: S Ramamurtum; "*Hydraulics, Fluid Mechanics and Fluid Machines*"; 8/e; Dhanpatrai Publishing Company ISBN 81-87433-84-1**.**

MT1III- M17 Applied Thermodynamics III

Properties of Steam and Vapour Processes: Formation of steam, Phase changes
Vapour Power Cycles: Carnot cycle, Rankine cycle, and Reheat & Regenerative cycle
Fuels and Combustion: Types of fuels, Proximate and ultimate analysis of fuel, Calorific value – HCV & LCV
Reference Books:

1. P. K. Nag; "*Engineering Thermodynamics*"; McGraw Hill Education Pvt. Ltd. ; 5/e ISBN 1-25-906256-2
2. Y. V. C. Rao; "*An Introduction to Thermodynamics*"; United Press ISBN 978-81-7371-461-0

MT1III-M18 Refrigeration and Air Conditioning I

Fundamentals of refrigeration: review of thermodynamics process isothermal, isentropic, Polytrophic and throttling process, Need of refrigeration reversed Carnot cycle, thermoelectric

refrigeration magnetic refrigeration, ultrasonic refrigeration, Vapour compression system, vapour absorption system.

Reference Books

1. Arora & Domkundwar; "*A Course in Refrigeration and Air Conditioning*"; dhanpat Rai and Sons, New Delhi.
2. C. P. Arora; "*Refrigeration and Air Conditioning*"; Tata McGraw Hill Publishing Ltd., New Delhi.
3. Ballaney P. L.; "*Refrigeration and Air Conditioning*"; Khanna Publishers, New Delhi. 1992

Project Stage – I and II [602817, 602819]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
602817	8	-	-	50	50	100	8
602819	20	-	-	150	50	200	20

Assessment of Project stage-I has to be carried out as per R-1.4 and R-1.5 of PG Rules and Regulations of Credit System.

INSTRUCTIONS FOR DISSERTATION WRITING

It is important that the procedures listed below be carefully followed by all the students of M.E. (Mechanical Engineering).

1. Prepare **Three Hard Bound Copies** of your manuscript.

2. Limit your Dissertation report to 80 – 120 pages (preferably)

3. The footer must include the following:
   Institute Name, M.E. Mechanical (Mechatronics) Times New Roman 10 pt. and centrally aligned.

4. Page number as second line of footer, Times New Roman 10 Pt, centrally aligned.

5. Print the manuscript using
   a. Letter quality computer printing.
   b. The main part of manuscript should be Times New Roman 12 pt. with alignment - justified**.**
   c. Use 1.5 line spacing.
   d. Entire report shall be of 5- 7 chapters.

6. Use the paper size **8.5'' × 11''** or **A4 (210 × 197 mm).** Please follow the margins given below.

Margin Location	Paper 8.5'' × 11''	Paper A4 (210 × 197 mm)
Top	1''	25.4 mm
Left	1.5''	37 mm
Bottom	1.25''	32 mm
Right	1''	25.4 mm

7. All paragraphs will be 1.5 line spaced with a one blank line between each paragraph. Each paragraph will begin with without any indentation.

8. Section titles should be bold with 14 pt typed in all capital letters and should be left aligned.

9. Sub-Section headings should be aligning at the left with 12 pt, bold and Title Case (the first letter of each word is to be capitalized).

10. Illustrations (charts, drawings, photographs, figures) are to be in the text. Use only illustrations really pertinent to the text. Illustrations must be sharp, clear, **black and white. Illustrations downloaded from internet are not acceptable.**
    a. Illustrations should not be more than **two** per page. One could be ideal
    b. Figure No. and Title at bottom with **12 pt**
    c. Legends below the title in **10 pt**
    d. Leave proper margin in all sides
    e. Illustrations as far as possible should not be photo copied.

11. **Photographs** if any should of glossy prints

12. Please use **SI** system of units only.

13. Please **number the pages** on the front side, centrally below the footer

14. **References** should be either in order as they appear in the thesis or in alphabetical order by last name of first author

15. **Symbols** and **notations** if any should be included in nomenclature section only

16. Following will be the order of report
    i. **Cover page** and **Front page** as per the specimen on separate sheet
    ii. **Certificate** from the Institute as per the specimen on separate sheet
    iii. **Acknowledgements**
    iv. **List of Figures**
    v. **List of Tables**
    vi. **Nomenclature**
    vii. **Contents**
    viii. **Abstract** (A brief abstract of the report not more than **150 words**. The heading of abstract i.e. word "Abstract" should be **bold, Times New Roman, 12 pt** and should be typed at the **centre.** The contents of abstract should be typed on new line without space between heading and contents. Try to include one or two sentences each on **motive, method, key-results** and **conclusions** in Abstract

1 Introduction (2-3 pages) (TNR – 14 Bold)
1.1 Problem statement (TNR – 12)
1.2 Objectives
1.3 Scope
1.4 Methodology
1.5 Organization of Dissertation

2 Literature Review (20-30 pages)
Discuss the work done so far by researchers in the domain area and their significant conclusions. No derivations, figures, tables, graphs are expected.

3 This chapter shall be based on your own work (Analytical/ Numerical/ Experimental) (15- 20 pages)

4 Experimental Validation - This chapter shall be based on your own experimental work (15-20 pages)

5 Concluding Remarks and Scope for the Future Work (2-3 pages)

References

ANNEXURE (if any)

(Put all mathematical derivations, Simulation program as Annexure)

17. All section headings and subheadings should be numbered. For sections use numbers **1, 2, 3, ….** and for subheadings **1.1**, **1.2**, **….** etc and section subheadings **2.1.1**, **2.1.2, ….** etc.

18. **References** should be given in the body of the text and well spread. No verbatim copy or excessive text from only one or two references. If **figures** and **tables** are taken from any reference then indicate source of it. Please follow the following procedure for references

Reference Books
Collier, G. J. and Thome, J. R., Convective boiling and condensation, 3rd ed., Oxford University Press, UK, 1996, pp. 110 – 112.

Papers from Journal or Transactions
Jung, D. S. and Radermacher, R., Transport properties and surface tension of pure and mixed refrigerants, *ASHRAE Trans*, 1991, 97 (1), pp. 90 – 98.

Bansal, P. K., Rupasinghe, A. S. and Jain, A. S., An empirical correction for sizing capillary tubes, *Int. Journal of Refrigeration*, 1996, 19 (8), pp.497 – 505.

Papers from Conference Proceedings
Colbourne, D. and Ritter, T. J., *Quantitative assessment of flammable refrigerants in room air conditioners*, Proc. of the Sixteenth International Compressor Engineering Conference and Ninth International Refrigeration and Air Conditioning Conference, Purdue University, West Lafayette, Indiana, USA, 2002, pp. 34 – 40.

Reports, Handbooks etc.
United Nations Environmental Programme, Report of the Refrigeration, Air Conditioning and Heat Pumps, Technical Option Committee, 2002, Assessment - 2002.

ASHRAE Handbook: Refrigeration, 1994 (Chapter 44)

Patent
Patent no, Country (in parenthesis), date of application, title, year.

Internet
www.(Site) [Give full length URL]

A Project Stage-I Report on (TNR, 16pt, centrally aligned)

Title (TNR, 27pt, Bold, Centrally Aligned, Title Case)

By (TNR, 16pt, Centrally Aligned)

Mr. Student's Name (TNR, 16pt, Centrally Aligned)

Guide

Guide's Name (TNR, 16pt, Centrally Aligned)

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Department of Mechanical Engineering

Name of the Institute

[2011-12](TNR, 22pt, Title Case Centrally Aligned)

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C E R T I F I C A T E

This is to certify that *Mr. Lele M.M.*, has successfully completed the Project Stage-I entitled "Performance analysis of……." under my supervision, in the partial fulfilment of Master of Engineering - Mechanical Engineering (Mechatronics) of University of Pune.

Date :

Place :

Guide's Name
Guide

_____
Head
Department and
Institute Name

External Examiner

Seal

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Principal,
Institute Name

A Dissertation on (TNR, 16pt, centrally aligned)

Title (TNR, 27pt, Bold, Centrally Aligned, Title Case)

By (TNR, 16pt, Centrally Aligned)

Mr. Student's Name(TNR, 16pt, Centrally Aligned)

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Guide

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Head
Department and
Institute Name

External Examiner

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