PDPM INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, DESIGN & MANUFACTURING JABALPUR

M.Tech Curriculum
Structure (Minimum credit 70)

SEMESTER-I			
Courses	**Credits**		
Professional and Communication Skill**	2 (S or X)	1-0-2-2	
Core	4	3-0-0-4	
Core	4 or 5(if Lab attached)	3-0-2-5 or 3-0-0-4	**17-20 credits**
Core / Elective	4	3-0-0-4	
Elective	4	3-0-0-4	
Lab1*/ lab attached to a course	*2/ attached with course	0-0-2-2	
SEMESTER-II			
Courses	**Credits**		
Core / Elective	4 or 5(if Lab attached)	3-0-2-5 or 3-0-0-4	
Elective	4	3-0-0-4	
Elective	4	3-0-0-4	**17-20 credits**
Elective or thesis credit	4	3-0-0-4	
Lab1/ lab attached to a course	*2/ attached with course	0-0-2-2	
SEMESTER-III			
Courses	**Credits**		
Thesis Credit	16	16	**18**
Graduate Seminar I	2	2	
SEMESTER-IV			
Courses	**Credits**		
Thesis Credit	16	16	**18**
Graduate Seminar II	2	2	

* Either lab will be attached to a core course or separate lab will be conducted
** The course can be floated either in 1st or 2nd Semester

MECHATRONICS

M.Tech. in Mechatronics

Semester I			
Sl. No	Course No	Course Title	Credits
1.	HS501(Core)	Professional Communication Skills	1-0-2-2
2.	ME581(Core)	Analytical Methods in Engineering	3-0-0-4
3.	MT501/MT502(Core)	Concepts in Mechanical Systems (for ECE and CSE students) Or Concepts in Electronic Devices (for Mechanical Students)	3-0-0-4
4	MT503 (Core)	Sensors and Actuators	3-0-2-5
5	Elective I		
4.	MT504L	Mechanical or Electronics Lab	0-0-2-2
Semester II			
1.	MT612(Core)	PLC and Microcontroller	3-0-2-5
2.	Elective II		3-0-0-4
3.	Elective III		3-0-0-4
4.	MT595	Mini Project	0-0-6-4
5.	MT612L	Lab is attached to course MT612(Core)	--
Semester III			
1.	MT598	Graduate Seminar II	2
2.	MT699	M.Tech Thesis	16
Semester IV			
1.	MT599	Graduate Seminar II	0-0-0-2
2.	MT699	M.Tech Thesis	16

Electives

1.	MT688	Automobile Electronics and Control	3-0-0-4
2.	ME535	Finite Element Methods for Mechanical Engineering	3-0-0-4
3.	EC 522	Power Electronics and Drives	3-0-0-4
4.	EC 422b	Application of Signal and Image Processing	3-0-0-4
5.	ME682	Robotics and Intelligent Systems	3-0-0-4
6.	EC 661	Fuzzy logic and Neural Networks	3-0-0-4
7.	ME687	Smart Materials and Structures	3-0-0-4
8.	ME686	MEMS: Microfabrication and Application	3-0-0-4
9.	EC420a	Advanced Control Systems	3-0-0-4
10.	ME651	Industrial Instrumentation and Metrology	3-0-0-4
11.	EC 551	Photonics Communication	3-0-0-4
12.	EC 407b	Internet of Things	3-0-0-4
13.	EC 553	Computational Electromagnetics	3-0-0-4
14.	ME612	Rapid Product Development Technologies	3-0-0-4
15.	ME636	Computational Fluid Dynamics	3-0-0-4
16.	ME611	NC-CNC Machine Tools and Programming	3-0-0-4
17.	ME631	Mechanical Vibrations and Condition Monitoring	3-0-0-4
18.	ME681	Engineering Optimization	3-0-0-4
19.	EC 549b	MEMS/NEMS and Sensors	3-0-0-4
20.	EC 513	Advance Time Frequency Analysis	3-0-0-4

CORE COURSES

Course Title	**:**	**ANALYTICAL METHODS IN ENGINEERING**			
Course Code	**:**	**ME581**	**Course Type**	**:**	**Compulsory**
Contact Hours	**:**	**L- 3 T- 1 P- 0**	**Credit**	**:**	**4**
Program/Semester	**:**	**M. Tech./ Semester-I**			
Pre-requisites	**:**	**None**			
Evaluation Scheme	**:**	**Quiz I (10%), Mid-Term (35%), Quiz II (10%), End-Term (45%)**			

Course Details:

INTRODUCTION. **[1 H]**

SOLUTION METHODS FOR ORDINARY DIFFERENTIAL EQUATIONS (ODEs)
First order differential equations, nth order differential equations **[5 H]**

FIRST-ORDER PARTIAL DIFFERENTIAL EQUATIONS (PDEs)
Classification, Analytical Solutions for Linear and Semi-linear equations **[5 H]**

SECOND-ORDER PDEs
Classification, Transformations to Canonical forms for Hyperbolic, Elliptic and parabolic Equations **[5 H]**

CONCEPTS IN APPROXIMATE SOLUTIONS OF DIFFERENTIAL EQUATIONS
Space of Functions: Inner product, Orthogonal functions, Norm, Projection of a Function onto an Orthogonal set, Gram-Schmidt Orthogonalization and Orthonormal set, Parseval's theorem **[5 H]**

FOURIER SERIES
Series of Trigonometric functions, Convergence of Fourier Series: Piecewise Continuous and Smooth function, Evaluation of Fourier Coefficients: Even and Odd functions, Even and odd extensions of a function, Uniform Convergence of a Fourier Series, Parseval's theorem for Fourier Series, Application of Parseval's theorem to estimate the Mean Square Error **[6 H]**

ANALYTICAL SERIES SOLUTIONS OF PDEs
Separation of Variables, Extension of Separation of Variables methodology by Method of Superposition, Rectangular coordinate system, Cylindrical coordinate system (Bessel function), Spherical coordinate system (Legendre function), Hyperbolic Equations, Elliptic Equations, Parabolic Equations **[5 H]**

FOURIER TRANSFORM AND ITS APPLICATIONS
Fourier Series to Fourier Integral, Properties of Fourier Transformation, Problems in Infinite and Semi-infinite Media, Solution of PDEs in Infinite and Semi-infinite Media, Dirac Delta Function **[5 H]**

LAPLACE TRANSFORM AND ITS APPLICATIONS
Fourier Transform to Laplace Transform, Review of Laplace Transform, Laplace Inverse Transform by Complex Number Residue theory, Solution of PDEs by Laplace Transform **[5 H]**

Suggested Textbooks:

1. . J B Doshi, “Differential Equations for Scientists and Engineers,” Narosa Publishing House, 2010.

2. Michael D Greenberg (1998), “Advanced Engineering Mathematics (2nd Ed),” Prentice Hall, (Indian Edition).

References:

1. Erwin Kreyszig, “Advanced Engineering Mathematics,” Wiley India, 1999.
2. T. Myint-U and L. Debnath, Linear Partial Differential Equations for Scientists and Engineers, Birkh¨auser, Boston, 2007.
3. M K Jain, S R K Iyengar and R K Jain, “Numerical Methods for Scientific and Engineering Computation,” New Age International Publisher, 2007

Course Title	**:**	**Concepts of Mechanical Systems**			
Course Code	**:**	**MT501**	**Course Type**	**:**	**Core**
Contact Hours	**:**	**L- 3 T- 0 P- 0**	**Credit**	**:**	**4**
Program/Semester	**:**	**M. Tech./Ist**			
Pre-requisites	**:**	**None**			
Evaluation Scheme	**:**	**Quiz (20%), Mid-Term (20%), End-Term (40%), Project (20%)**			

Course Details:

MECHANISMS:
Definition - Machine and Structure - Kinematic link, pair and chain - classification of Kinametic pairs - Constraint & motion - Degrees of freedom - Slider crank - Single and double – Crank rocker mechanisms - Inversions - applications. Kinematic analysis and synthesis of simple mechanisms- Determination of velocity and acceleration of simple mechanisms. (10 Hrs)

Stress and Strain
Concepts of stress, Stress-strain diagram, Mechanical Properties – elasticity, Ductility, Toughness. Design of shafts – bending, torsion and combined loading. (12 Hrs)

TRANSMISSION SYSTEMS:
Gears Involute - fundamental law of gearing - interference - condition for correct gearing. Gear Trains - simple, compound, epicyclic. Gear Drives – Constant Mesh, Sliding mesh and Synchromesh. (10 Hrs)

VIBRATION:
Introduction - Undamped Free- Damped free - Forced vibrations. (10 Hrs)

Suggested Textbooks:

References:

1. Rattan S.S., .Theory of Machines., TMH
2. Thomas Bevan, .Theory of Machines., CBS
3. Theory of Mechanisms & Machines by Ghosh & Mallick, EWP
4. John J. Uicker, Jr., Gordon R. Pennock and Joseph E. Sigley (2005), "Theory of Machines and Mechanisms (3rd Ed)," Oxford University Press, Indian Edition.
5. K J Waldron and G L Kinzel (2004), "Kinematics, Dynamics and Design of Machinery (2nd Ed)," Wiley.
6. Shigley, J., Mechanical Engineering Design, Sixth Edition, Tata McGraw Hill, 2003.
7. Bhandari, V., Design of Machine Elements, Second Edition, Tata Mc-Graw Hill, 2007.
8. Thomson, W.T., Theory of vibration with applications, Third Edition, 1997.
9. Rao, S. S., Mechanical Vibrations, Fourth Edition, Addison Wesley, 2004

Course Title	**:**	**Concepts of Electronics Devices**			
Course Code	**:**	**MT502**	**Course Type**	**:**	**Core**
Contact Hours	**:**	**L- 3 T- 0 P- 0**	**Credit**	**:**	**4**
Program/Semester	**:**	**M. Tech./Ist**			
Pre-requisites	**:**	**None**			
Evaluation Scheme	**:**	**Quiz (20%), Mid-Term (20%), End-Term (40%), Project (20%)**			

Course Details:

Review of theory of semiconductor, PN junction diode theory, contact potential and current components, energy band diagram for PN Junction, Diode I-V Characteristics, breakdown voltage and leakage current Diode applications rectifier half wave and full wave with filter design, clipping and clamping circuit analysis and design, Special purpose diodes zener diode and its application for regulator, varactor diode, PIN diode, tunnel diode, photodiode, Schottkey barrier diode and LED.

Junction field effect transistor (JFET), device structure and physical operation, IV characteristics, n-channel and p-channel JFET, Biasing and small signal analysis and JEFT applications as voltage amplifier. MOSFET basics, the inversion cannel formation, the derivation of the IV characterises, triode region and saturation region operation, body effect and channel length modulation, Modeling of the MOSFET, Basing, Common source, common drain, and common gate configurations. MOSFET as an amplifier and as a Switch, Single stage MOS Amplifier, MOSFET small signal model for analysis of single stage amplifier, high frequency MOSFET model and frequency response, Current mirror, differential amplifier using MOSFET.

Operation of BJT, Current Components, currents gains α and β, BJT Biasing and Q point & Regions of Operation, Bias Stability, Transistor in CB, CE, CC configuration, Transistor leakage current I_{CBO} and I_{CEO} and breakdowns. Introduction to amplifiers, RC Coupled amplifiers, frequency response, Transistor re Model, Transistor H parameter, BJT Small Signal Analysis, BJT and FET High frequency modelling, Transistor as a switch and power dissipation in the transistor.

Feedback Amplifiers, Oscillators (Different types), Differential Amplifiers, power amplifier, Operational Amplifiers and its Applications. Logic Families using BJT and MOSFET for Digital Applications.

Suggested Textbooks:

1

References:

1. *Electronic Circuits Analysis and Design,* Donald Neamen.
2. *Microelectronics Circuits* 5th Edition BySedra and Smith Oxford Publication
3. *Electronic Devices and Circuits* David A Bell. Oxford Publication
4. *Integrated Electronics: Analog and Digital Circuits and Systems,* Millman Jacob and Halkias, Christos C. ,McGraw Hill 2004
5. *Electronics Device and Circuit Theory*Boylestad,Robert L. and NashelskyLouis,Ninth Edition, Printice Hall of India 2005

Course Title	**:**	**Sensors and Actuators**			
Course Code	**:**	**MT503**	**Course Type**	**:**	**Elective**
Contact Hours	**:**	**L- 2 T- 0 P- 2**	**Credit**	**:**	**4**
Program/Semester	**:**	**M. Tech./Ist**			
Pre-requisites	**:**	**None**			
Evaluation Scheme	**:**	**Quiz (10%), Mid-Term (20%), End-Term (40%), Lab (20%) Project (10%)**			

Course Details:

INTRODUCTION: Definition – Measurement Techniques – Classification of errors – Error analysis, Static and dynamic characteristics of transducers – general requirements for interfacing and actuation – Performance Characteristics of Sensors and Actuators: Input/output characteristics, accuracy, errors, repeatability, sensitivity analysis, hysteresis, nonlinearity, saturation, frequency response, dynamic characteristics, calibration, resolution, excitation, impedance. **[4 H]**

SENSORS: Classification of sensors – calibration techniques – Potentiometer – strain gauges – optical encoders. **[3 H]**

INDUCTANCE AND CAPACITANCE TRANSDUCER: LVDT – RVDT – Synchro – Microsyn – Applications: Pressure, position, angle and acceleration. Capacitance circuitry – Feedback type condenser microphone – frequency modulating oscillator circuit – Dynamic capacitance variation – A.C. Bridge for Amplitude Modulation – Applications: Proximity, microphone, pressure, displacement. **[6 H]**

MAGNETIC SENSORS & ACTUATORS: Motors as actuators (linear, rotational, AC, DC, Servo and step motors), Torque Motion Characteristics, Motor Selection and Applications. Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall effect - Eddy current. Magnetostrictive sensors and actuators, Magnetometers (fluxgate, search-coil, Squid), Voice coil actuators (speakers and speaker-like actuators), Electrorheological and magnetorheological actuators, Bolometers (microwaves) **[6 H]**

PIEZOELECTRIC SENSORS & ACTUATORS: Piezoelectric Materials and properties – Modes of deformation – Multimorphs – Environmental effects – Applications: Accelerometer, ultrasonic, Piezoelectric actuators, Piezoelectric resonators, Microphones, hydrophones, speakers, buzzers. **[5 H]**

THERMAL SENSORS & ACTUATORS: Thermoelectric effects, temperature measurement, thermocouple, resistance temperature device (RTD), thermistor, infra red sensor, linear actuator, lateral thermal actuator, volumetric actuator, bimorph actuators and switches **[4 H]**

Suggested Textbooks:

1. Clarence W de Silva, MECHATRONICS - An Integrated Approach, CRC Press; and
2. Alan S Morris, Measurement and Instrumentation Principles, Butterworth-Heinemann

References:

1. T.R. Hsu "*MEMS And Microsystems: Design And Manufacture*", McGraw Hill Education, New Delhi 2002.
2. N. P. Mahalik, "*MEMS*", McGraw Hill Education, New Delhi 2007.

Course Title	**:**	**PLC and Microcontroller**			
Course Code	**:**	**MT612**	**Course Type**	**:**	**Elective**
Contact Hours	**:**	**L-2 T- 0 P- 4**	**Credit**	**:**	**5**
Program/Semester	**:**	**M. Tech.**			
Pre-requisites	**:**	**None**			
Evaluation Scheme	**:**	**Quiz (15%), Mid-Term (15%), End-Term (40%), Project (20%), Lab (10%)**			

Course Details:

Programmable Logic Controllers

Introduction – PLC Architecture – Principles of operation – PLC sizes – PLC hardware components – I/O section: Analog I/O modules – digital I/O modules, CPU processor memory module – Programming devices. **(3 H)**

PLC Programming:

PLC programming Simple instructions – Manually operated switches – Mechanically operated and Proximity switches -Output control devices - Latching relays PLC ladder diagram, Converting simple relay ladder diagram in to PLC relay ladder diagram. **(3 H)**

Timer instructions ON DELAY, OFF DELAY and RETENTIVE and pulse Timers, UP COUNTER, DOWN COUNTER and UP DOWN COUNTERS. **(3H)**

Control instructions – SFC, FBD, Combinational and event driven logic, Data manipulating instructions, math instructions; Jump and call instructions. **(3H)**

Applications of PLC **(2H)**

Microcontroller

Microcontroller Hardware – I/O Pins, Ports – External memory, EEPROM – Counters and Timers – Serial data I/O – Interrupts – Assembly Language Programming: Instruction set, Addressing modes, Data transfer instructions, Arithmetic and Logical Instructions, Jump and Call Instructions, interrupts and returns interrupts and returns interrupt handling. Timer-Counter, PWM. **(14 H)**

Suggested Textbooks:

References:

1. Embedded Controller Hand book, Intel Corporation, USA.
2. Microcontroller Hand Book, INTEL, 1984.
3. David E. Simon, An Embedded Software Primer, Pearson Education
4. John W. Webb, Programm
5. Industrial Electronics: Circuits, instruments and control techniques-Terry Bartelt – Delmar pub.
6. Muhammad Ali Mazidi and Janice Gillispic Mazdi, "The 8051 Microcontroller and Embedded Systems" Pearson Education, Inc 2006.
7. John B. Peatman, Design with Micro controllers, McGraw Hill International, USA, 2005.
8. Kenneth Hint, and Daniel Tabak, Micro controllers, Architecture, Implementation and programming, McGraw Hill International, USA, 1992.
9. James W. Stewart, "The 8051 Micro controller hardware, software and interfacing, regents

Prentice Hall, 2003.
10. John B. Peatman, PLC programing, McGraw Hill International, USA, 2005.
11. Morton John, “AVR: An Introductory Course”, Elsevier, 2003
12. Frank D. Petruzella. “Programmable Logic Controllers”, McGraw–Hill Book, Company, 1989

ELECTIVES

Course Title	**:**	**Automobile Electronics and Control**			
Course Code	**:**	**MT688**	**Course Type**	**:**	**Elective**
Contact Hours	**:**	**L- 3 T- 0 P- 0**	**Credit**	**:**	**4**
Program/Semester	**:**	**M. Tech./Ist**			
Pre-requisites	**:**	**None**			
Evaluation Scheme	**:**	**Quiz (20%), Mid-Term (20%), End-Term (40%), Project (20%)**			

Course Details:

1. Fundamentals of Automotive Electronics: Microprocessor and micro Computer applications in automobiles; components for engine management System; electronic management of chassis system; vehicle motion control; electronic panel meters.
2. Sensors & Actuators: Introduction; Basic sensor arrangement; Types of Sensors such as oxygen sensors, Crank angle position sensors, fuel metering/vehicle speed sensors and detonation sensors, altitude sensors, flow Sensors, throttle position sensors, solenoids, stepper motors, relays.
3. Electronic Fuel Injection & Ignition System: Introduction; feed back carburetor system; throttle body injection and multi point fuel injection System; injection system controls; advantage of electronic ignition systems; types of solid state system and their principle of operation; electronic spark timing.
4. Digital Engine Control System: Open loop and closed loop control system; engine cooling and warm-up control; acceleration, deceleration and idle speed control; integrated engine control system; exhaust emission control engineering; on-board diagnostics; future automotive electronic systems.
5. Automotive Electrical: Batteries; starter motor & drive mechanism; D.C. generator and alternator; regulation for charging; lighting design; dashboard instruments; horn, warning system and safety devices.
6. Comfort & Safety: Seats, mirrors and sun roofs; central locking and electronic Windows; cruise control; in-car multimedia; security; airbag and belt tensioners; other safety and comfort systems; new developments.
7.The system approach to control &instrumentation: Fundamentals, electronic components and circuits, digital electronics, microcomputer instrumentation and control, sensors and actuators, digital engine control systems, vehicle motion control, automotive instrumentation and telematics, new
developments.
8. Electromagnetic Interference Suppression: Electromagnetic compatibility Electronic dash board instruments - Onboard diagnosis system. Security and warning system.

Suggested Textbooks:

References:

1. Automotive Electronics Handbook**,** Ronald K. Jurgen, McGraw Hill Publishing Co., ISBN 0-07-034453-1.
2. Automotive Electricity and Electronics, Al Santini, Delmar Publishers, NY, ISBN 0-8273-6743-0.
3. Automobile Electrical & Electronic Equipments, Young, Griffitns, Butterworth Publication, London.
4 Understanding Automotive Electronics**,** Bechfold, SAE 1998

Course Title	**:**	**FINITE ELEMENTS METHODS FOR MECHANICAL ENGINEERING**			
Course Code	**:**	**ME535**	**Course Type**	**:**	**Elective**
Contact Hours	**:**	**L- 3 T- 0 P- 0**	**Credit**	**:**	**4**
Program/Semester	**:**	**M. Tech. / Semester-II**			
Pre-requisites	**:**	**None**			
Evaluation Scheme	**:**	**Quiz I (10%), Mid-Term (20%), Quiz II (10%), End-Term (40%) Project (20%)**			

Course Details:

Introduction to FEM

Need of finite element method, process of finite element method, field and boundary conditions, steps involved in fem, weighted residual methods, virtual work as the 'weak form' of equilibrium equations for analysis of solids or fluids, variational principles, establishment of natural variational principles for linear, self-adjoint differential equations, maximum, minimum, or a saddle point, constrained variation principles, lagrange multipliers and adjoin functions. **[12 H]**

Plane Strain and Stress

Introduction, two – dimensional elements, completeness of polynomials, rectangular elements – lagrange family, rectangular elements – 'serendipity' family, triangular element family- CST and LST Elements. **[6 H]**

Errors and Accuracy

Error, mistakes and accuracy. Convergence criteria, discretization error and convergence rate, non-conforming elements and the patch test. **[3 H]**

Plate Bending and Shell Elements

Kirchhoff and Mindlin Elements. Full integration, reduced integration, selective reduced integration, Membrane and shear Locking. 8-noded and 9-noded elements, Heterosis Element **[8 H]**

Three – Dimensional Stress Analysis

Introduction, modeling of solids, tetrahedral and hexahedron elements. Axisymmetric Elements. **[5 H]**

Dynamic Considerations

Formulation; element mass matrices; Eigen values and eigenvectors evaluation generalized Jacobi method; tridiagonalization; implicit symmetric QR step with Wilkinson; shift for diagonalization; Guyan reduction. **[6 H]**

Introduction to non-linear finite element. **[2 H]**

Suggested Textbooks:

1. J N Reddy, An introduction to the Finite Element Method, McGraw-Hill, New York, 1993.
2. R D Cook, D S Malkus and M E Plesha, Concepts and Applications of Finite Element Analysis, 3 ed., John Wiley, New York, 1989.

References:

1. K J Bathe, Finite Element Procedures in Engineering Analysis, Prentice-Hall, Englewood Cliffs, NJ, 1982.
2. T J T Hughes, The Finite Element Method, Prentice-Hall, Englewood Cliffs, NJ, 1986.
3. O C Zienkiewicz and R L Taylor, The Finite Element Method, 3d ed. McGraw-Hill, 1989

Course Title	**:**	**Power Electronics and Drives**			
Course Code	**:**	**EC 522**	**Course Type**	**:**	**Elective**
Contact Hours	**:**	**L-3 T- 0 P- 0**	**Credit**	**:**	**4**
Program/Semester	**:**	**M. Tech./Ist**			
Pre-requisites	**:**	**None**			
Evaluation Scheme	**:**	**Quiz (20%), Mid-Term (20%), End-Term (40%), Project (20%)**			

Course Details:

Introduction: Classification of Electric Drives, Requirements of Electric Drives, Some Applications.
Converters and control: Phase controlled converters, Four quadrant operation, Choppers, AC to DC converters.
DC motor drives: Speed-torque characteristics DC shunt, PMDC and series motors, Dynamic model, Speed and position control methods.
Inverters and PWM: Voltage source inverters, current source inverters, PWM techniques, sine triangle comparison, harmonic elimination, hysteresis current controllers, space vector PWM.
AC motor drives: d-q model of induction motor, constant flux speed control structure, vector control model, vector control structure**.**

Suggested Textbooks:

References:

13. Mohan, Undeland, Robbins, "Power Electronics", 3rd edition, John Wiley & Sons, 2002.
14. Bose B.K., "Modern Power Electronics & AC Drives", 1st edition, PHI, 2002.
15. P. C. Sen., “Principles of Electrical Machines and Power Electronics”, John Wiley & Sons, 1997.
16. M. H. Rashid, "Power Electronics - Circuits, Devices and Applications", P.H.I Private Ltd. New Delhi, Second Edition, 1994

Course Title	**:**	**Applications of Signal and Image Processing**			
Course Code	**:**	**EC 422b**	**Course Type**	**:**	**Elective**
Contact Hours	**:**	**L- 3 T- 0 P- 0**	**Credit**	**:**	**4**
Program/Semester	**:**	**M. Tech./Ist**			
Pre-requisites	**:**	**None**			
Evaluation Scheme	**:**	**Quiz (10%), Mid-Term (20%), End-Term (40%), Lab (20%) Project (10%)**			

Course Details:

ECG: Cardiac electrophysiology, relation of electrocardiogram (ECG) components to cardiac events, clinical applications.

Speech Signals: The source-filter model of speech production,spectrographic analysis of speech.

Speech Coding: Analysis-synthesis systems, channel vocoders, linear prediction of speech, linear prediction vocoders.

Imaging Modalities: Survey of major modalities for medical imaging: ultrasound, X-ray, CT, MRI, PET, and SPECT.

MRI: Physics and signal processing for magnetic resonance imaging.

Surgical Applications: A survey of surgical applications of medical image processing. Image Segmentation: statistical classification, morphological operators, connected components.

Application of Signal and Image Processing in power and control systems and mobile robot using physiological signals.

Suggested Textbooks:

References:

1. Oppenheim, A. V., and R. W. Schafer, with J. R. Buck. *Discrete-Time Signal Processing*. 2nd ed. Upper Saddle River, NJ: Prentice-Hall, 1999. ISBN: 9780137549207.
2. Karu, Z. Z. *Signals and Systems Made Ridiculously Simple*. Huntsville, AL: ZiZi Press, 1995. ISBN: 9780964375215.
3. Duda, R., and P. Hart. *Pattern Classification and Scene Analysis*. New York, NY: John Wiley & Sons, 1973. ISBN: 9780471223610.
4. Clifford, G., F. Azuajae, and P. McSharry. *Advanced Methods and Tools for ECG Data Analysis*. Norwood, MA: Artech House, 2006. ISBN: 9871580539661.
5. Rabiner, L. R., and R. W. Schafer. Digital Processing of Speech Signals. Upper Saddle River, NJ: Prentice-Hall, 1978. ISBN: 9780132136037.
6. Lim, J. S. Two-Dimensional Signal and Image Processing. Upper Saddle River, NJ: Prentice Hall, 1989. ISBN: 9780139353222.
7. Gonzalez, R., and R. E. Woods. Digital Image Processing. 2nd ed. Upper Saddle River, NJ

Course Title	**:**	**Robotics and Intelligent Systems**			
Course Code	**:**	**ME682**	**Course Type**	**:**	**Elective**
Contact Hours	**:**	**L- 3 T- 0 P- 0**	**Credit**	**:**	**4**
Program/Semester	**:**	**M. Tech.**			
Pre-requisites	**:**	**Basic course on Robotics**			
Evaluation Scheme	**:**	**Quiz (20%), Mid-Term (20%), End-Term (40%), Project (20%)**			

Course Details:

Introduction: Components and mechanisms of a robotic system, Robot Manipulators, Mobile Robots, Aerial Robots, Applications. **[2H]**

Review of robot manipulators: Importance and evolution of robotic manipulators, robot classifications, applications, robot specifications, Forward kinematics, Inverse kinematics, Velocity Kinematics, Manipulator Jacobian, Manipulator Dynamics: Newton-Euler formulation, Euler-Lagrange formulation. **[6H]**

Path and Trajectory Planning: Joint-space schemes, Cartesian-space schemes, configuration space, path planning using potential fields, Avoiding local minima, Probabilistic roadmap methods; Trajectory planning: PTP method, using Via points. **[6H]**

Linear Control of Manipulators: Feedback Control: Proportional, Derivative and Integral Control, PID control, regulation problem, tracking problem, model based control, trajectory-following control. **[8H]**

Nonlinear Control of Manipulators: Feed forward control, Feedback Linearization, PD control with gravity compensation, Computed toque control, Adaptive Control, Robust Control, Sliding Mode Control, Lyapunov stability analysis, Cartesian based control schemes. **[6H]**

Redundant Manipulators: Singularity and Workspace analysis, redundancy resolution, obstacle avoidance and singularity avoidance. **[4H]**

Artificial Intelligence: An overview of the filed of Artificial intelligence. Neural Networks: Fundamentals, Back propagation model, Other models, control Applications. Genetic Algorithms and Evolutionary computing : Optimization Examples. Fuzzy Systems : Fundamentals; Fuzzy Control; Hybrid Systems. Rough Sets : Basics; Knowledge Extraction from data; Control Applications. Chaos; Applications. **[10H]**

Suggested Textbooks:

1 1. R.K. Mittal and I.J. Nagrath, Robotics and Control, McGraw Hill, 2016

References:

I. B.Siciliano, L. Sciavicco, L. Villani, G.Oriolo, Robotics- Modelling, Planning and Control, Springer, 2009.

II. Reza N. Jazar, Theory of Applied Robotics- Kinematics, Dynamics, and Control , Springer, 2007.

III. M.W.Spong, S.Hutchinson and M. Vidyasagar, Robot Modelling and Control,2006.

IV. B. Siciliano, O. Khatib (Eds), Springer Handbook of Robotics, Springer, 2008.

V. Mark W Spong, M Vidyasagar, Robot Dynamics And Control, John Wiley and Sons, 2008.

VI. Richard M. Murray, Zexiang Li, S. S. Sastry, A Mathematical Introduction to Robotic Manipulation, CRC Press, 1994.

VII. Russell Stuart, Norvig Peter, “Artificial Intelligence Modern Approach”, Pearson

Education series in AI, 3rd Edition, 2010.

VIII. Dan.W. Patterson, "*Introduction to Artificial Intelligence and Expert Systems*", PHI Learning, 2009

IX. Gregory Dudek and Michael Jenkin, Computational Principles of Mobile Robotics, Second Edition, 2010, Cambridge University Press. (ISBN 978-0-521-69212-0 paperback or 978-0-521-87157-0 hardback)

X. S Mahadevan and J Connell, Robot Learning, Kluwer Academic, 1993

Course Title	**:**	**Fuzzy logic and Neural Networks**			
Course Code	**:**	**EC** 661	**Course Type**	**:**	**Elective**
Contact Hours	**:**	**L- 3 T- 0 P- 0**	**Credit**	**:**	**4**
Program/Semester	**:**	**M. Tech./Ist**			
Pre-requisites	**:**	**None**			
Evaluation Scheme	**:**	**Quiz (10%), Mid-Term (20%), End-Term (40%), Lab (20%) Project (10%)**			

Course Details:

Fuzzy Logic: Classical sets – Fuzzy sets – Membership function – Fuzzy relations – Knowledge base – Fuzzification– Fuzzy rules – Decision-making logic – Defuzzification. Mamdani and TakagiSugeno architectures of Fuzzu inference system.

Neural Networks: Introduction to Neural Networks – Biological neuron – Artificial neuron – Neuron modeling – Learning rules – Single layer – Multi layer feed forward network – Back propagation – Learning factors. Error back-propagation, generalized delta rule, Radial basis function networks.

ANFIS: Adaptive Neuro-Fuzzy Inference System (ANFIS), Adaptive linear element (ADALINE).

Applications: Engineering applications of Neural Network and Fuzzy Logic system.

Suggested Textbooks:

References:

1. T. J. Ross, 'Fuzzy Logic with Engineering Applications', Tata McGraw Hill, 1997.
2. J. M. Zurada, 'Introduction to Artificial Neural Systems', Jaico Publishing home, 2002.
3. Simon Haykin, 'Neural Networks', Pearson Education, 2003

4. Bork Kosk, "Neural Networks and Fuzzy Logic System", PHI Publications.

5. Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence,'' by J.S.R. Jang, C.T. Sun, and E. Mizutani, Prentice Hall, 1996.

Course Title	**:**	**Smart Materials and Structures**			
Course Code	**:**	**ME687**	**Course Type**	**:**	**Elective**
Contact Hours	**:**	**L- 3 T- 0 P- 0**	**Credit**	**:**	**4**
Program/Semester	**:**	**M. Tech.**			
Pre-requisites	**:**	**None**			
Evaluation Scheme	**:**	**Quiz (20%), Mid-Term (20%), End-Term (40%), Project (20%)**			

Course Details:

Introduction to smart materials and their applications; Piezoelectric, magnetostrictive, and electrostrictive materials. Shape memory alloys, electrorheological and magnetorheological fluids. **[10 H]**

Piezoelectric Material Systems: Fundamentals of Piezoelectricity, Piezoelectric Actuators and Sensors: Principle, working and modeling; Piezoelectric Beams and Plates: Modeling and analysis. **[8 H]**

Shape Memory Alloys: Fundamentals of SMA Behavior; Constitutive Modeling, Actuation Models of Shape Memory Alloys **[8 H]**

Electroactive Polymer Materials: Classification of Electroactive Polymers; Actuator and Sensor Equations of Ionomeric Polymer Transducers. **[8 H]**

Applications of Smart Materials such as Energy Harvesting, MEMS and NEMS, Active vibration Control. **[8H]**

Suggested Textbooks:

1. Vijay K. Varadan, K. J. Vinoy, S. Gopalakrishnan, Smart Material Systems and MEMS: Design and Development Methodologies, Wiley, 2006

References:

I. Donald J. Leo, Engineering analysis of smart material systems, John Wiley Sons, Inc., 2007.

II. A V Srinivasan and D Michael McFarland, ―Smart Structures – Analysis and Design,‖ Cambridge University Press, 2001.

III. Inderjit Chopra and Jayant Sirohi, Smart Structures Theory, Cambridge University Press, 2014.

Course Title	**:**	**MEMS: Microfabrication and Application**			
Course Code	**:**	**ME686**	**Course Type**	**:**	**Elective**
Contact Hours	**:**	**L- 3 T- 0 P- 0**	**Credit**	**:**	**4**
Program/Semester	**:**	**M. Tech.**			
Pre-requisites	**:**	**None**			
Evaluation Scheme	**:**	**Quiz (10%), Mid-Term (30%), End-Term (40%), Project (20%)**			

Course Details:

Introduction: The History of MEMS Development; The Intrinsic Characteristics of MEMS; Devices: Sensors and Actuators; Scaling Laws. **[2H]**

Materials for MEMS: Silicon-Compatible Material System; Other Materials and Substrates; Important Material Properties and Physical Effects. **[5H]**

Processes for Micromachining: Basic Processing Tools; Advanced Process Tools; Nonlithographic Microfabrication Technologies; Combining the Tools—Examples of Commercial Processes. **[15H]**

Review of Essential Electrical and Mechanical Concepts: Conductivity of Semiconductors; Crystal Planes and Orientations; Stress and Strain; Flexural Beam Bending Analysis Under Simple Loading Conditions; Torsional Deflections; Intrinsic Stress; Dynamic System, Resonant Frequency, and Quality Factor; Active Tuning of Spring Constant and Resonant Frequency. **[8H]**

MEM Structures and Systems in Industrial and Automotive Applications: General Design Methodology; Techniques for Sensing and Actuation; Passive Micromachined Mechanical Structures; Sensors and Analysis Systems; Actuators and Actuated Microsystems **[6H]**

MEM Structures and Systems in Photonic Applications: Imaging and Displays; Fiber-Optic Communication Devices; **[2H]**

MEMS Applications in Life Sciences: Microfluidics for Biological Applications; DNA Analysis; Microelectrode Arrays. **[2H]**

Suggested Textbooks:

1. N. Maluf, K. Williams, "An Introduction to Microelectromechanical Systems Engineering", 2e, Artech House, Massachusetts, 2004.
2. C. Liu "*Foundations of MEMS*", *2e,* Pearson Education, New Jersy, 2012.

References:

1. T.R. Hsu "*MEMS And Microsystems: Design And Manufacture*", McGraw Hill Education, New Delhi 2002.
2. N. P. Mahalik, "*MEMS*", McGraw Hill Education, New Delhi 2007.

Course Title	**:**	**Advanced Control Systems**			
Course Code	**:**	**EC** 420a	**Course Type**	**:**	**Elective**
Contact Hours	**:**	**L- 3 T- 0 P- 0**	**Credit**	**:**	**4**
Program/Semester	**:**	**B.Tech VIII**			
Pre-requisites	**:**	**None**			
Evaluation Scheme	**:**	**Quiz (10%), Mid-Term (20%), End-Term (40%), Lab (20%) Project (10%)**			

Course Details:

Introductions: Introduction and applications of Control Theory in different fields.

State Variable Analysis and Design: State Variable Representation, Conversion between State Variable Models to Transfer function and Vice-versa, Eigen Values, Eigen Vectors, Diagonalization, Solution of State Equations, Controllability and Observability, Pole placement by State feedback, Design of State Observer: Full order and Reduced order state observer, Compensator Design by Separation Principle Servo Design: Introduction of the Reference input by Feed-forward Control, State Feedback with integral Control.

Digital Control System, The z-transform, Inverse z-transform, Pulse Transfer Function, z- and s-plane relationship, z-transform analysis of Sampled-data Control System, Stability analysis of Sampled-data Control System.

Design of Feedback Control System: Preliminary consideration of Classical Design, Realization and Design of Basic Compensator, Design of PID controller .

Design of Digital Control System: Z-plane Specifications of Control System Design, Digital Compensator Design using Frequency Response Plots, Digital Compensator design using Root locus plots, Design of Digital PID controller.

Optimal Control Systems: Parameter Optimization, Optimal Control Problem: Transfer Function Approach, Optimal Control Problem: State Variable Approach.

Introduction to Adaptive Control(Model Reference Adaptive Control).

Some Applications

Suggested Textbooks:

References:

1. Digital Control and State Variable Methods by M Gopal, McGraw-Hill, 2003
2. Control Systems Engineering by I J Nagrath and M Gopal, New age International, 2007

Course Title	**:**	**Industrial Instrumentation & Metrology**			
Course Code	**:**	**ME651**	**Course Type**	**:**	**Elective**
Contact Hours	**:**	**3L-0 T- 0 P- 0**	**Credit**	**:**	**4**
Program/Semester	**:**	**M. Tech. / Semester-I/II**			
Pre-requisites	**:**	**None**			
Evaluation Scheme	**:**	**Quiz I (5%), Mid-Term (35%), Quiz II (10%), End-Term (50%),**			

Course Details:

Theory and Experimentation in Engineering: Problem solving approaches, Types of engineering experiments, computer simulation and physical experimentation; Generalized measuring system, types of inputs, analog and digital signals, standards, calibration and uncertainty (4H)
Measurement System: Performance characteristics, static performance characteristics-static calibration-linearity, static sensitivity, repeatability, hysteresis threshold-resolution, readability and span (3H)
Analysis of Experimental Data : Causes and types of experimental error, un-certainty analysis, statistical analysis of data, probability distributions and curve fitting; Dynamic performance characteristics; Input types; Instrument types- zero order instrument, first order instrument, second order instrument (3H)
Measurement of pressure; Flow measurement and flow visualization; measurement of temperature; optical methods of measurements; Data Acquisition and Processing (15H)
Types and configurations of DAS, signal conditioning, A/D, D/A conversion; Design, Planning, Execution and Analysis of experimental projects (8H)
Measurement of Acceleration, Vibration And Density
Accelerometers - LVDT, Piezoelectric, Strain gauge and Variable reluctance type accelerometers - Mechanical type vibration instruments - Seismic instruments as accelerometer – Vibration sensor - Calibration of vibration pickups - Units of density and specific gravity – Baume scale and API scale - Pressure type densitometers - Float type densitometers – Ultrasonic densitometer - gas densitometer. (8H)
Metrology:
Measurement of length, measurement of angle, Measurement of geometric forms, straightness, flatness, roundness etc. Mechanical and optical methods. Measurement of screw threads and gears. Measurement of surface roughness and texture. Introduction to CMM. In-process gages. Inspection and quality monitoring. (4H)

Suggested Textbooks:

1. Mechanical Measurements by S.P. Venketeshan ,IIT, Madras, Ane Books Pvt. Ltd, 4821, Parwana Bhawan, 1st Floor, 24 Ansari Road, Darya Ganj, New Delhi - 110 002.
2. Engineering Metrology by R.K. Jain, Khanna Publishers, New Delhi, 1997

Reference

1. E.O. Doebelin, Measurement systems- Applications and Design, 4th Ed., Tata McGraw-Hill, 1990.
2. T.G. Beckwith, R.D. Marangoni and J.H. Lienhard, Mechanical Measurements, 5th Ed., Addison Wesley, 1993.
3. Holman, Experimental Methods for Engineers, 6e, McGraw-Hill, 1994.

Course Title	**:**	**Photonics Communication**			
Course Code	**:**	**EC 551**	**Course Type**	**:**	**Elective**
Contact Hours	**:**	**L- 3 T- 0 P- 0**	**Credit**	**:**	**4**
Program/Semester	**:**	**M. Tech./II**			
Pre-requisites	**:**	**None**			
Evaluation Scheme	**:**	**Quiz (10%), Mid-Term (20%), End-Term (40%), Lab (20%) Project (10%)**			

Course Details:

Guided Wave Optics: Ray and Wave Optics, Slab Waveguides, Optical Fibers, propagation of light in multimode and single mode fibers, coupling into and out of a fiber, attenuation, group velocity, dispersion, and optical non-linearity. [12H]

Photonic Devices: Optical Processes in Semiconductors, PN Junctions, Semiconductor Heterostructures, Optical sources - LEDs and Lasers, Photo-detectors - pin- detectors, APD, detector responsivity, noise, optical receivers, Optical- Modulators, Amplifiers, Multiplexers/De-Multiplexers and Switches. [13H]

Optical Communication: Fiber optic communication, Analog and Digital transmission system, wavelength division multiplexing (WDM), DWDM, SONET/SDH, Wavelength routed networks, Solition based communication, Optical CDMA. [15H]

Suggested Textbooks:

Integrated Photonics: fundamentals by G.Lifante
Fiber Optic Communication by G.Keiser

References:

1. Optical Networks: A Practical Perspective by R.Ramaswami and Kumar N Sivrajan

Course Title	**:**	**Internet of Things (IoT)**			
Course Code	**:**	**EC 407b**	**Course Type**	**:**	**Elective**
Contact Hours	**:**	**L- 3 T- 0 P- 0**	**Credit**	**:**	**4**
Program/Semester	**:**	**B.Tech VIII**			
Pre-requisites	**:**	**None**			
Evaluation Scheme	**:**	**Quiz (10%), Mid-Term (20%), End-Term (40%), Lab (20%) Project (10%)**			

Course Details:

IoT definitions: overview, applications, potential & challenges, and architecture.
Internet in general and Internet of Things, Internet of Everything, Web of Things, and Making Things Smart.
IoT communication protocols, packets, services, performance parameters of a packet network as well as applications such as web, Peer-to-peer, sensor networks, and multimedia.
Business Issues, Aspects and Models of the Internet of Things. Making and Getting Things onto the Internet.
Local Area Networks, MAC level, link protocols such as: point-to-point protocols, Ethernet, WiFi 802.11, cellular internet access, and Machine-to-machine.
Mobile Networking: roaming and handoffs, mobile IP, and ad hoc and infrastructure less networks.

IoT examples: Case studies, e.g. sensor body-area-network and control of a smart home.

Suggested Textbooks:

Kurose, James F.; Ross, Keith W. **Computer networking: a top-down approach,** 5th ed., international ed.: Boston, Mass.: Pearson, cop. 2010

References:

Course Title	**:**	**Computational Electromagnetics**			
Course Code	**:**	**EC 553**	**Course Type**	**:**	**Elective**
Contact Hours	**:**	**L- 3 T- 0 P- 0**	**Credit**	**:**	**4**
Program/Semester	**:**	**M. Tech./Ist**			
Pre-requisites	**:**	**None**			
Evaluation Scheme	**:**	**Quiz (10%), Mid-Term (20%), End-Term (40%), Lab (20%) Project (10%)**			

Course Details:

Review of Electromagnetic theory, Introduction to Computational Electromagnetics, Difference Approximations based on One-Dimensional Wave Equation, Numerical Dispersion & Group Delay, Stability of Explicit Solution, Implicit Formulation and Stability [12
Maxwell's Equations in 1, 2, and 3 dimensions, Yee algorithm, Numerical Dispersion, Numerical Stability, Source Excitation: Total-Field/Scattered-Field Formulation, Waveguide Source Excitations, [10]

Analytical Absorbing Boundary Conditions, Perfectly Matched Layer Media, Near Field to Far Field Transformations, [8]

Modelling Lumped Elements, Modelling of Antennas, Electromagnetic Crystals and Metamaterials, Artificial Engineered Materials, Microcavity resonators. [10]

Suggested Textbooks:

Computational Electrodynamics: The FDTD, Allen Talfov and S.C.Hagness, Artech House
Electromagnetic Simulation Using FDTD Method, Dennis M Sullivan, IEEE Press Series on RF and Microwave Technology.

References:

Course Title	**:**	**Rapid Product Development Technologies**			
Course Code	**:**	**ME612**	**Course Type**	**:**	**Elective**
Contact Hours	**:**	**L- 3 T- 0 P- 0**	**Credit**	**:**	**4**
Program/Semester	**:**	**M. Tech.**			
Pre-requisites	**:**	**None**			
Evaluation Scheme	**:**	**Mid Sem Exam (20%), End Sem Exam (40%), Quizzes/Programming Assignment (20%) and Programming/Automation Project (20%)**			

Course Details:

Overview of Rapid Product Development:
Product Developing Cycle, Components of RPD, Classification of manufacturing processes. Preprocessing: Solid Modeling, Data exchange formats, STL file format, RP Preprocessing. **[4 H]**

Rapid Prototyping (RP):
Introduction to RP, Need of RP; Basic Principles of RP, Steps in RP, Process chain in RP in integrated CAD-CAM environment, Advantages of RP, Classifications of different RP techniques, Selection of RP processes, Issues in RP, Emerging trends. **[8 H]**

RP Techniques:
Solid RP, liquid RP techniques and Powder RP Techniques - Process Technology and Comparative study of Selective laser sintering, Selective powder binding, etc. **[10 H]**

Rapid Tooling (RT):
Introduction to RT, Indirect RT processes – silicon rubber molding, epoxy tooling, spray metal tooling and investment casting. Direct RT processes – laminated tooling, powder metallurgy based technologies, welding based technologies, direct pattern making, emerging trends in RT. **[5 H]**

Reverse Engineering:
Geometric data acquisition, 3D reconstruction. **[5 H]**

Applications and case studies:
Engineering applications, Medical applications **[5 H]**

Special Topic on RP:
Programming in RP, Modelling, Slicing, Internal Hatching, Surface Skin Fills, Support Structure. Overview of the algorithms for RP&T and Reverse Engineering. **[5 H]**

Suggested Textbooks:

1. Chua, C.K., Leong, K.F., Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley and Sons Inc., 2000.

References:

1. Pham, D.T., Demov, S.S., Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer-Verlag London Limited, 2001.
2. Hopkinson, N., Hague, R.J.M. and Dickens, P.M., Rapid Manufacturing and Industrial Revolution for the Digital Age, John Wiley and Sons Ltd, Chichester, 2005.
3. Noorani, R., Rapid Prototyping: Principles and Applications, John Wiley & Sons, Inc., New Jersey, 2006.
4. Zeid, I., Mastering CAD/CAM, Tata McGraw Hill, 2006
5. Gebhardt, A., Rapid Prototyping, Hanser Gardner Publications, Inc., Cincinnati, 2003.
6. Gibson, I., Software Solutions for Rapid Prototyping, Professional Engineering Publication Ltd., 2002.
7. Patri, K. V., and Weiyin, Ma, Rapid Prototyping - Laser-based and Other Technologies, Kluwer Academic Publishers, U.S.A., 2003.

8. Rapid Prototyping Journal
9. Journal of Virtual and Physical Prototyping
10. Selected papers from International Journal of Machine Tools and Manufacture, International Journal of Advanced Manufacturing Technology, Computer Aided Design, Computer Aided Design and applications, etc.
11. Mortenson, M.E., Geometric Modelling, John Wiley and Sons, Inc., 1997
12. Saxena, A., Sahay, B., Computer Aided Engineering Design, Anamaya Publishers, New Dehi, 2005
13. Rogers, D.F and Adams, J.A., Mathematical Elements for Computer Graphics, Tata McGraw Hill, 2002.
14. Zeid, I., CAD/CAM: Theory and Practice, Revised First Edition, Tata McGraw Hill, 2007.
15. Faux, I. D. and Pratt, M. J., Computation Geometry for Design and Manufacture, John Wiley (Ellis Horwood Ltd.), 1983.
16. Venuvinod, P.K. and Ma, W., Rapid prototyping: Laser based and other technologies, Kluwer Academic Publishers,2004.
17. Gibson, I., Advanced Manufacturing Technology For Medical Application, John Wiley & Sons,Singapore,2005.
18. Kamrani, A.K. and Nasr, E.A., Rapid Prototyping Theory And Practice , Springer,USA ,2006.
19. Hilton, P.D. and Jacobs, P.F., Rapid Tolling: Technologies and Industrial Applications, Dekker,New York ,2005.
20. Bidanda, B. and Bartolo, P., Virtual Prototyping & Bio Manufacturing In Medical Applications, Springer, USA ,2008.

Course Title	**:**	**Computational Fluid Dynamics**			
Course Code	**:**	**ME636**	**Course Type**	**:**	**Elective**
Contact Hours	**:**	**L- 3 T- 0 P- 0**	**Credit**	**:**	**4**
Program/Semester	**:**	**M. Tech.**			
Pre-requisites	**:**	**None**			
Evaluation Scheme	**:**	**Assignment (10%), Quizzes (20%), Project (20%), Mid-sem (15%) and End-sem (35%)**			

Course Details:

1. Review of equations governing fluid flow and heat transfer, common boundary conditions. **[3 H]**
2. Review of Matrix inversion techniques. **[3 H]**
3. Finite-difference method, discretisation and numerical solutions. **[4 H]**
4. 1-D steady-state conduction problem, tridiagonal matrix solution. **[3 H]**
5. 2-D steady-state conduction problem, Line-by-line method. **[3 H]**
6. Time-stepping, explicit and implicit schemes. **[3 H]**
7. 2-D unsteady conduction problems, explicit scheme. **[4 H]**
8. Implicit scheme, Gauss-Seidel algorithm, ADI. **[3 H]**
9. Wave-equation discretisation, Upwind and other convective schemes. **[2 H]**
10. Dispersion and dissipation errors, stability and consistency. **[3 H]**
11. Vorticity-streamfunction formulations **[3 H]**
12. Navier-Stokes Equations- SMAC schemes. **[3 H]**
13. Finite Volume Method **[3 H]**
14. Operator-Splitting Algorithm **[3 H]**

Suggested Textbooks:

1. Computational Fluid Flow and Heat Transfer, Eds K. Muralidhar and T. Sundararajan, Narosa, India.

References:

1. Computer Simulation of Flow and Heat Transfer, P.S. Ghoshdastidar, Tata McGraw Hill.
2. Computational Fluid Flow and Heat Transfer, Tannehill, Anderson &Pletcher, Taylor & Francis Series
3. Computational Methods for Fluid Dynamics, Ferziger & Peric, Springer

Course Title	**:**	**NC-CNC Machine Tools and Programming**			
Course Code	**:**	**ME611**	**Course Type**	**:**	**Compulsory/Elective**
Contact Hours	**:**	**L- 3 T- 0 P- 0**	**Credit**	**:**	**4**
Program/Semester	**:**	**M. Tech.**			
Pre-requisites	**:**	**None**			
Evaluation Scheme	**:**	**Mid Sem Exam (25%), End Sem Exam (40%), Quizzes/Programming Assignment (15%) and Programming/Automation Project (20%)**			

Course Details:

Automation

Types of automation, Programmed Automation, History of Numerical Control, Components of NC: Punched Tape, MCU, Processing Unit, Axis Designation, NC Motion Control: PTP, Straight cut, Contouring NC Coding System: EIA & ISO format, ApplicationNumerical Control, Advantages, & Disadvantages, Adoptive Control System **[5H]**

Computer Numerical Control

Block Diagram of CNC operations, Positioning System: Open loop and Closed loop System, Precision in NC Positioning: Control resolution, Accuracy, Repeatability **[8H]**

Part Programming

Procedures Associated with part programming, Cutting process parameter selection, Process planning issues and path planning, Part programming formats, G & M Codes, Interpolations, Canned Cycles and Subprograms,Tool Compensations **[12H]**

CNC Hardware Basics

Machines Structure, Guidways: Requirements, types and design features, Actuation systems: Ball Screws, Introduction of Servo and Stepper Motors, Feedback devices: Encoder, Optical grating, Resolvers, Inductosyn **[5H]**

Modern CNC Systems

Indexable carbide tools,Modular Tooling & Tool Presetting, Machining Centers, Automatic tool changers **[2H]**

Computer Aided Part Programming

APT Programming, Part Program Generation through ProE/DelCAM, Post Processors **[5H]**

Computations for part programming

Segmentations of free form curves, Consideration for INTOL and OUTTOL, Part programming for Bezier and B-spline Curves, Generating part program from CAD drawings **[5H]**

Suggested Textbooks:

1. Rao P N.,‖CAD/CAM Principles and Practice‖, Tata McGraw-Hill

References:

1. Robert Quesada, T. Jeyapoovan, ―Computer Numerical Control : Machining Center and Turning Centers‖ , Tata McGraw-Hill
2. S K SINHA,‖CNC Programming‖, Galgotia Pubs.
3. CNC Machine Manuals
4. Chang, Wysk and Wang, Computer Aided Manufacturing, Prentice Hall International. 3rd Edition
5. Kochan D., CAM: Developments in Computer Integrated Manufacturing System, Springer Verlag.
6. Chang, T.C., An Introduction to Automated Process Planning Systems, Prentice Hall International.
7. Kundra, Rao and Tiwari, Numerical Control and CAM, TMH.
8. Koren, Computer Control of Manufacturing Systems, TMH.
9. Kochan D., Integration of CAD/CAM, North Holland.

Course Title	**:**	**MECHANICAL VIBRATIONS AND CONDITION MONITORING**			
Course Code	**:**	**ME631**	**Course Type**	**:**	**Compulsory**
Contact Hours	**:**	**L- 3 T- 0 P- 2**	**Credit**	**:**	**5**
Program/Semester	**:**	**M. Tech. / Semester-I**			
Pre-requisites	**:**	**None**			
Evaluation Scheme	**:**	**Quiz I (10%), Mid-Term (15%), Quiz II (10%), Lab (15 %), End-Term (35%) Project (15%)**			

Course Details:

Review of Free and forced vibrations of single degree of freedom system. Vibration isolation and transmissibility, Vibration measuring instruments. **[6 H]**

Multi Degrees of freedom systems, Introduction, Influence co-efficient, Maxwell reciprocal theorem, Automobile vehicle suspension, coupling, Vibration absorbers, Various numerical methods for solution of multi degree of freedom systems. **[10 H]**

Whirling of shafts with and without air damping. Discussion of speeds above and below critical speeds. **[4 H]**

Vibration of Continuous Systems: Introduction, vibration of string, longitudinal vibration of rods, torsional vibration of rods, Euler's equation for beams, simple problems. **[6 H]**

Non-linear vibration, Phase Plane, Conservative systems, Stability of equilibrium. The Duffing Oscillator. **[6 H]**

Introduction to condition monitoring of machinery, Condition monitoring methods, Types and Benefits of Vibration Analysis. Vibration Signals from Rotating and Reciprocating Machines. Signal Classification, Stationary and Cyclostationary signals. **[10 H]**

Experiment:

1. Whirling of shaft
2. Simulation of multi-degree of freedom system on MATLAB
3. Simulation of contiuous system on MATLAB
4. Study of Force Vibration due to rotary unbalance
5. Study of Force Vibration due to base excitation
6. Vibration measurement on shaker and comparison of input and output
7. Study and measurement of engine vibration
8. Study and measurement of vibration on bearing test rig.
9. Study and measurement of vibration on gear test rig.
10. Simulation of nonlinear vibration of pendulum

Suggested Textbooks:

1. Rao, S. S., Mechanical Vibrations, Fourth Edition, Addison Wesley, 2004.
2. Inman, Mechanical Vibrations, Second Edition, Pearson, 2015

References:

1. Randall. R.B., Vibration-Based Condition Monitoring: Industrial, Aerospace and Automotive Applications, Wiley, United Kingdom, 2011.
2. Caollacott, R. A.; Chapman, Mechanical Fault Diagnosis and Condition Monitoring, Chapman and hall, 1977.
3. Rao, J. S., Advanced Theory of Vibration, Wiley Eastern Ltd. New Delhi, 1992.

Course Title	**:**	**Engineering Optimization**			
Course Code	**:**	**ME681**	**Course Type**	**:**	**Elective**
Contact Hours	**:**	**L- 3 T- 0 P- 0**	**Credit**	**:**	**4**
Program/Semester	**:**	**M. Tech.**			
Pre-requisites	**:**	**None**			
Evaluation Scheme	**:**	**Quiz (20%), Mid-Term (30%), End-Term (50%)**			

Course Details:

Classical Optimization method

Single variable optimization; Multi variable optimization with no constraints (semidefinite case, saddle point), with equality constraints (solution by direct substitution, method of constrained variation, method of Lagrange multipliers), with inequality constraints (Kuhn-Tucker conditions, constraint qualification); Convex programming problem, NLP: One dimensional minimization methods **[8 H]**

Elimination methods: Interval halving method; Fibonacci method; Golden section method **[5 H]**

Interpolation method: Direct root methods (Newton method, quasi-Newton method, secant method), NLP: Unconstrained optimization techniques **[4 H]**

Direct search methods: Random search; Grid search; Univariate; Pattern directions; Hooke and Jeeves' method; Powell (conjugate directions, algorithms); Rosenbrocks; Simplex (Reflection, Expansion, Contraction) **[5 H]**

Indirect search methods: Gradient of a function; Steepest descent (Cauchy); Conjugate gradient (Fletcher-Reeves); Newton's; Marquardt; Quasi-Newton (Variable metric); Davidon-Fletcher-Powell; Broydon-Fletcher-Goldforb-Shanno; NLP: Constrained optimization techniques **[5 H]**

Direct methods: Random search method; Sequential linear programming; Feasible directions (basic approach); Feasible directions (Zoutendijk's method); Rosen's gradient projection; Generalized reduced gradient; Sequential quadratic programming **[4 H]**

Indirect methods: Transformation techniques; Penalty function method (basic approach); Interior penalty function method; Convex programming; Exterior penalty function; Interior penalty function method (Extrapolation technique); Penalty function method (Mixed equality and inequality constraints); Penalty function method (Parametric constraints); Augmented Lagrange multiplier method; Checking convergence; Integer programming (IP) **[6 H]**

Integer linear programming: Graphical representation; Gomory's cutting plane; Bala's algorithm for 0-1 programming **[2 H]**

Integer nonlinear programming: Integer polynomial programming; Branch and bound method; Sequential linear discrete programming; Generalized penalty function method **[3 H]**

Suggested Textbooks:

1. Engineering Optimization: Theory and Practice by SS Rao

References:

1. Mokhtar S. Bazaaraa, Hanif D. Shirali and M.C.Shetty, "Nonlinear Programming, Theory and Algorithms", John Wiley & Sons, New York (2004).
2. S. S. Rao, "Engineering Optimization: Theory and Practice", 4th Edition, John Wiley & Sons (2009).
3. Kwang Y. Lee, Mohamed A. El-Sharkawi, "Modern heuristic optimization techniques: theory and applications", Kluwer (2008).
4. Hamdy A. Taha, "Operations Research: An Introduction", 8th Edition, Pearson Education (2008).
5. G. V. Reklaitis, A. Ravindran, K. M. Ragsdell, "Engineering Optimization: Methods and

Applications", Wiley (2006).
6. Michael C. Bartholomew-Biggs, "Nonlinear optimization with engineering applications", Springer (2008).

Course Title	**:**	**MEMS/NEMS and Sensors**			
Course Code	**:**	**EC549b**	**Course Type**	**:**	**Elective III**
Contact Hours	**:**	**L- 3 T- 0 P- 0**	**Credit**	**:**	**04**
Program/Semester	**:**	**M.Tech/Sem II**			
Pre-requisites	**:**	**None**			
Evaluation Scheme	**:**	**Quiz I (15%), Mid-Term (30%), Quiz II (15%), End-Term (40%)**			

Course Details:

Introduction

MEMS and NEMS definitions, taxonomy of Nano and Microsystems synthesis and design, classification and considerations, biomimetics, biological analogies, and design, biomimetics fundamentals, biomimetics for NEMS and MEMS, Nano-ICs and nano-computer architectures. [10H]

Modelling Of Micro and Nano Scale Electromechanical Systems

Introduction to modelling, analysis and simulation, basic electro-magnetic with application to MEMS and NEMS, modelling developments of micro-and nano actuators using electromagnetic-Lumped-parameter mathematical models of MEMS, energy conversion in NEMS and MEMS. [10H]

Inorganic and Organic Enabled Sensors

Introduction-types of sensors-Mechanical, optical, spintronics, bioelectronics and biomagnetic sensors-surface modification-surface materials and interactions and its examples. [10H]

Sensor Characteristics and Physical Effects

Introduction to sensors, static Characteristics and dynamic characteristics, Physical effects: Photoelectric-effect, Photoluminescence-effect, Electroluminescence-effect ,Chemiluminescence-effect, Doppler-effect , Hall -effect, thermoelectric-effect, magneto-optical phenomena. [5H]

Future Nanosystems

Nano machines, nano robots, electronics based on CNT, molecular Electronics. Quantum Computation: Future of Meso/Nanoelectronics? -Interfacing with the Brain, towards molecular medicine, Lab-on-BioChips- Guided evolution for challenges and the solutions in NanoManufacturing technology. [7H]

Suggested Textbooks:

1) *Micro-Electro Mechanical and Nano-Electro Mechanical Systems, Fundamental of Nano- and Micro-Engineering*Sergey Edward Lyshevski, 2nd Ed., CRC Press, (2005).

2) *Nanomaterials: Synthesis, Properties and Applications Institute of Physics*, A. S. Edelstein and Cammarata, Bristol, Philadelphia: Institute of Physics, (2002).

3) *Micro manufacturing and Nanotechnology*, N. P. Mahalik, Springer Berlin Heidelberg New York (2006).

4) *Micro and Nanomanufacturing*, Mark J. Jackson, (2007).

5) *Nanofabrication, Principles, Capabilities and Limits*,Zheng Cui, (2008).

6) *Nanotechnology Enabled Sensors*, Kalantar–Zadeh K, Springer, (2008).

7) *Future trends in MicroElectronics*, Serge Luryi, Jimmy Xu, Alex Zaslavsky, John Wiley & Sons, Inc. Hoboken, New Jersey (2007).

Course Title	**:**	**Advance time frequency analysis**			
Course Code	**:**	**EC513**	**Course Type**	**:**	**Elective**
Contact Hours	**:**	**L- 3 T- 0 P- 0**	**Credit**	**:**	**04**
Program/Semester	**:**	**M.Tech.**			
Pre-requisites	**:**	**NA**			
Evaluation Scheme	**:**	**Quiz I (10-15%), Mid-Term (20-40%), Quiz II (10-15%), End-Term (40-60%), Assignment (0-20%)**			

Course Details:

Basics of Fourier Analysis, The Short-Time Fourier Transform/Spectrogram, Continuous Wavelet Transform/Scalogram, S-tranform. [10H]

Quadratic Time Frequency Transform, Wigner-Ville Distribution (WVD), PWVD, SPWVD, Margenau–Hill (MH), and Rihaczek (RIH) distributions, pseudo-MH (PMH) and pseudo-WV (PWV) [10H]

Empirical Mode decomposition, Improved EMD, and Other non-stationary signal decomposition [10H]

Non-stationary decomposition based statistical analysis, features extraction. [10H]

Application of Time frequency in biomedical signal processing. [10H]

Suggested Textbooks:

[1] S. Mallat, A Wavelet Tour of Signal Processing (3rd edition), Academic Press, 2008, ISBN: 978-0123743701.
[2] Leon Cohen, Time-Frequency Analysis, Prentice Hall; 1994, ISBN: 978-0135945322.
[3] B. Boashash, Time-Frequency Signal Analysis and Processing: A Comprehensive Reference, Elsevier Science, 2003, ISBN-13: 978-0080443355.
[4] R. M. Rao and A. S. Bopardikar, Wavelet Transforms: Introduction to Theory& Applications, Prentice Hall, 1998, ISBN-13: 978-020163463

References:

IEEE International Symposium on Time-Frequency and Time-ScaleAnalysis, IEEE Press, NY, 1992. (Publ. TH4788 or ISBN 0-7803-0805-0)