Course structures of M.Tech. Programme in Mechatronics

	Courses	**Credits**	**Total**
Semester I	Core Theory courses (3-0-0-6): 2 Elective Theory courses (3-0-0-6): 3 Mechatronics Lab : I (0-0-3-3) HSS Elective (2-0-04)	2×6 = 12 3×6 = 18 3 4	**37**
Semester II	Core Theory courses (3-0-0-6) : 2 Elective Theory courses (3-0-0-6): 3 Mechatronics Lab : II (0-0-3-3) Seminar (0-0-4-4)	2×6 = 12 3×6 = 18 3 4	**37**
Semester III	Project phase I (24)	24	**24**
Semester IV	Project phase II (24)	24	**24**

Total credit = 122

Name of the courses:

Core Courses

1. MH501: Fundamentals of Mechatronics (3-0-0-6)
2. MH503: Advanced Engineering Mathematics (3-0-0-6)
3. MH502: Sensors and Actuators (3-0-0-6)
4. MH504: Modeling and Simulation of Mechatronic Systems (3-0-0-6)

Elective Courses (Elective I –III)

1. ME501: Robotics: Advanced Concepts and Analysis (3-0-0-6)
2. ME533: Finite Element Analysis (3-0-0-6)
3. CS561 Artificial Intelligence (3-0-0-6)
4. EE501: Control of Mechatronic Systems (3-0-0-6)
5. EE503: Signal Processing in Mechatronic Systems (3-0-0-6)

Elective Courses (Elective IV –VI)

1. ME502: Industrial Automation (3-0-0-6)
2. ME504**:** Vehicle Dynamics and Multi-body Systems (3-0-0-6)
3. ME506: Emerging Smart Materials for Mechatronics Applications (3-0-0-6)
4. EE508: Intelligent Visual Surveillance Systems (3-0-0-6)
5. EE504:Microprocessors and Embedded Systems (3-0-0-6)

Lab & Seminar Courses

1. MH519: Mechatronic Laboratory-I (0-0-3-3)
2. MH520: Mechatronic Laboratory-II (0-0-3-3)
3. MH507: Seminar (0-0-4-4)
4. MH603: Project phase I
5. MH604: Project phase II

Detailed syllabus:

(Core courses)

MH501: Fundamentals of Mechatronics (3-0-0-6)

Module I**:** Introduction: Definition of Mechatronics, Mechatronics in manufacturing, Products, and design. Comparison between Traditional and Mechatronics approach

Module II: Review of fundamentals of electronics. Data conversion devices, sensors, microsensors, transducers, signal processing devices, relays, contactors and timers. Microprocessors controllers and PLCs.

Module III: Drives: stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, transfer systems

Module IV: Hydraulic systems: flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, pumps. Design of hydraulic circuits. Pneumatics: production, distribution and conditioning of compressed air, system components and graphic representations, design of systems. Description

Module V: Description of PID controllers. CNC machines and part programming. Industrial Robotics.

Texts:

1. HMT ltd. *Mechatronics*, Tata Mcgraw-Hill, New Delhi, 1988.

2. G.W. Kurtz, J.K. Schueller, P.W. Claar II, *Machine design for mobile and industrial applications*, SAE,
1994.

3. T.O. Boucher, *Computer automation in manufacturing - an Introduction*, Chappman and Hall, 1996.

4. R. Iserman, Mechatronic Systems: Fundamentals, Springer, 1st Edition, 2005

5. Musa Jouaneh, Fundamentals of Mechatronics, 1st Edition, Cengage Learning, 2012

MH503: Advanced Engineering Mathematics (3-0-0-6)

Prerequisite NIL

Linear Algebra: Matrix algebra; basis, dimension and fundamental subspaces; solvability of Ax = b by direct Methods; orthogonality and QR transformation; eigenvalues and eigenvectors, similarity transformation, singular value decomposition, Fourier series, Fourier Transformation, FFT.

Vector Algebra & Calculus: Basic vector algebra; curves; grad, div, curl; line, surface and volume integral, Green’s theorem, Stokes’s theorem, Gauss-divergence theorem.

Differential Equations: ODE: homogeneous and non-homogeneous equations, Wronskian, Laplace transform, series solutions, Frobenius method, Sturm-Liouville problems, Bessel and Legendre equations, integral transformations; PDE: separation of variables and solution by Fourier Series and Transformations, PDE with variable coefficient.

Numerical Technique: Numerical integration and differentiation; Methods for solution of Initial Value Problems, finite difference methods for ODE and PDE; iterative methods: Jacobi, Gauss-Siedel, and successive over-relaxation.

Complex Number Theory: Analytic function; Cauchy’s integral theorem; residue integral method, conformal mapping.

Statistical Methods: Descriptive statistics and data analysis, correlation and regression, probability distribution, analysis of variance, testing of hypothesis.

Text Books:

1. H. Kreyszig, "*Advanced Engineering Mathematics*", Wiley, (2006).
2. Gilbert Strang, "*Linear Algebra and Its Applications*", 4th edition, Thomson Brooks/Cole, India (2006).
3. J. W. Brown and R. V. Churchill, "*Complex Variables and Applications*", McGraw-Hill Companies, Inc., New York (2004).
4. J. W. Brown and R. V. Churchill, "*Fourier Series and Boundary Value Problems*", McGraw-Hill Companies, Inc., New York (2009).
5. G. F. Simmons, "*Differential Equations with Applications and Historical Notes*", Tata McGraw-Hill Edition, India (2003).
6. S. L. Ross, "*Differential Equations*" 3rd edition, John Wiley & Sons, Inc., India (2004).
7. K. S. Rao, "*Introduction to Partial Differential Equations*", PHI Learning Pvt. Ltd (2005).
8. R. Courant and F. John, "*Introduction to Calculus and Analysis, Volume I and II*", Springer-Verlag, New York, Inc. (1989).
9. K. Atkinson and W. Han, "*Elementary Numerical Analysis*" 3rd edition, John Wiley & Sons, Inc., India (2004).
10. R. A. Johnson and G. K. Bhattacharya, "*Statistics, Principles and Methods*", Wiley (2008).

MH502: Sensors and Actuators (3-0-0-6)
Prerequisite: NIL

Brief overview of measurement systems, classification, characteristics and calibration of different sensors. Measurement of displacement, position, motion, force, torque, strain gauge, pressure flow, temperature sensor sensors, smart sensor. Optical encoder, tactile and proximity, ultrasonic transducers, opto-electrical sensor, gyroscope. Principles and structures of modern micro sensors, micro-fabrication technologies: bulk micromachining, surface micromachining, LIGA, assembly and packaging

Pneumatic and hydraulic systems: actuators, definition, example, types, selection. Pneumatic actuator. Electro-pneumatic actuator. Hydraulic actuator, control valves, valve sizing valve selection. Electrical actuating systems: solid-state switches, solenoids, voice coil; electric motors; DC motors, AC motors, single phase motor; 3-phase motor; induction motor; synchronous motor; stepper motors. Piezoelectric actuator: characterization, operation, and fabrication; shape memory alloys.

Text Books

1. John G. Webster, Editor-in-chief, "*Measurement, Instrumentation, and Sensors Handbook*", CRC Press (1999).
2. Jacob Fraden, "*Handbook of modern Sensors*", AIP Press, Woodbury (1997).
3. Nadim Maluf, "*An Introduction to Microelectromechanical Systems Engineering*", Artech House Publishers, Boston (2000).
4. Marc Madou, "*Fundamentals of Microfabrication*", CRC Press, Boca Raton (1997).
5. Gregory Kovacs, "*Micromachined Transducers Sourcebook*", McGraw-Hill, New York (1998).
6. E. O. Deobelin and D. Manik, "*Measurement Systems – Application and Design*", Tata McGraw-Hill (2004).
7. D. Patranabis, "*Principles of Industrial Instrumentation*", Tata McGraw-Hill, eleventh reprint (2004).
8. B. G. Liptak, "*Instrument Engineers' Handbook: Process Measurement and Analysis*", CRC (2003).

MH504: Modelling and Simulation of Mechatronic Systems (3-0-0-6)
Prerequisite NIL
Physical Modelling: Mechanical and electrical systems, physical laws, continuity equations, compatibility equations, system engineering concept, system modelling with structured analysis, modelling paradigms for mechatronic system, block diagrams, mathematical models, systems of differential-algebraic equations, response analysis of electrical systems, thermal systems, fluid systems, mechanical rotational system, electrical-mechanical coupling.
Simulation Techniques: Solution of model equations and their interpretation, zeroth, first and second order system, solution of 2nd order electro-mechanical equation by finite element method, transfer function and frequency response, non-parametric methods, transient, correlation, frequency, Fourier and spectra analysis, design of identification experiments, choice of model structure, scaling, numeric methods, validation, methods of lumped element simulation, modelling of sensors and actuators, hardware in the loop simulation (HIL), rapid controller prototyping, coupling of simulation tools, simulation of systems in software (MATLAB, LabVIEW) environment.
Modelling and Simulation of Practical Problems:
· Pure mechanical models
· Models for electromagnetic actuators including the electrical drivers
· Models for DC-engines with different closed loop controllers using operational amplifiers
· Models for transistor amplifiers
· Models for vehicle system

Text Books:
1. L. Ljung, T. Glad, "*Modeling of Dynamical Systems*", Prentice Hall Inc. (1994).
2. D.C. Karnopp, D.L. Margolis and R.C. Rosenberg, "*System Dynamics: A Unified Approach*", 2nd Edition, Wiley-Interscience (1990).
3. G. Gordon, "*System Simulation*", 2nd Edition, PHI Learning (2009).
4. V. Giurgiutiu and S. E. Lyshevski, "*Micromechatronics, Modeling, Analysis, and Design with MATLAB*", 2nd Edition, CRC Press (2009).

Lab Courses
MH519: Mechatronics Laboratory-I (0-0-3-3)
Prerequisite NIL
Demonstration of mechatronics hardwares; servo- position and velocity control; process control; basic programming using microprocessor/microcontroller; ADC and DAC interfacing with microcontroller/microprocessor; machine condition monitoring; development of multiple sensor fusion; image based navigation and control of robot; control of non-linear systems; machine vision inspection and image surveillance; mini-projects on mechatronic system design.

MH520: Mechatronics Laboratory-II (0-0-3-3)
Prerequisite NIL
NC machine tool; sequence planning in CIM; automatic quality inspection in CIM; microprocessor/ microcontroller based control; 3 DOF gyroscope; design and fabrication of piezo-actuator; hydraulic actuator; pneumatic actuator; design and characterization of optical sensor

(Elective Courses) (Elective I-III)

ME501 Robotics: Advanced Concepts and Analysis (3-0-0-6)

Prerequisite NIL

Introduction to robotics: brief history, types, classification and usage and the science and technology of robots.

Kinematics of robot: direct and inverse kinematics problems and workspace, inverse kinematics solution for the general 6R manipulator, redundant and over-constrained manipulators.

Velocity and static analysis of manipulators: Linear and angular velocity, Jacobian of manipulators, singularity, static analysis.

Dynamics of manipulators: formulation of equations of motion, recursive dynamics, and generation of symbolic equations of motion by a computer simulations of robots using software and commercially available packages.

Planning and control: Trajectory planning, position control, force control, hybrid control

Industrial and medical robotics: application in manufacturing processes, e.g. casting, welding, painting, machining, heat treatment and nuclear power stations, etc; medical robots: image guided surgical robots, radiotherapy, cancer treatment, etc;

Advanced topics in robotics: Modelling and control of flexible manipulators, wheeled mobile robots, bipeds, etc. Future of robotics.

Reference Books

1. M. P. Groover, M. Weiss, R. N. Nagel and N. G. Odrey, "*Industrial Robotics-Technology, Programming and Applications*", McGraw-Hill Book and Company (1986).

2. S. K. Saha, "*Introduction to Robotics*", Tata McGraw-Hill Publishing Company Ltd. (2008).

3. S. B. Niku, "*Introduction to Robotics–Analysis Systems, Applications*", Pearson Education (2001).

4. A. Ghosal, Robotics: "*Fundamental Concepts and Analysis*", Oxford University Press (2008).

5. Pires, "*Industrial Robot Programming–Building Application for the Factories of the Future*", Springer (2007).

6. Peters, "*Image Guided Interventions – Technology and Applications*", Springer (2008).

7. K. S. Fu, R. C. Gonzalez and C.S.G. Lee, "*ROBOTICS: Control, Sensing, Vision and Intelligence*", McGraw-Hill (1987).

8. J. J. Craig, "*Introduction to Robotics: Mechanics and Control*", 2nd edition, Addison-Wesley (1989).

ME533 Finite Element Analysis (3-0-0-6)

Matrix methods review, Rayleigh-Ritz and Galerkin's method, weak formulations, FEM formulation in one dimension, interpolation, Multipoint constraints, applications to solid mechanics, heat transfer and fluid mechanics problems, Solution to truss and frame elements, temperature effect, Euler Bernoulli and Timoshenko beam element, C^0 and C^1 elements, Hermite cubic spline functions, shear locking. Eigen value problem and applications, semidiscrete FEM models, Time approximation schemes, Problems in 2-D, plane stress, plane strain, torsion problems, isoparametric formulations, axisymmetric elements, higher order elements, Serendipity elements, quaterpoint element, hybrid element, numerical intergration, reduced integration, convergence and accuracy, norms, modeling consideration, computer implementation: example problems in different fields: solid mechanics, heat transfer, fluid flow etc.

Review of equations of elasticity, velocity pressure formulation, LMM and PM model, Limitations of FEM.

Text Book:

1. Reddy, J.N., “An Introduction to Finite Element Methods”, 3rd Ed., Tata McGraw-Hill. 2005.

Reference Books:

1. Zienkiewicz, O. C. “The Finite Element Method, 3rd Edition, Tata McGraw-Hill. 2002.
2. Cook, K.D., Malkus, D.S. and Plesha, M.E., “Concept and Applications of Finite Element Analysis”, 3th Ed., John Wiley and Sons. 1989.
3. Rao, S.S., “The Finite Element Method in Engineering”, 4th Ed., Elsevier Science. 2005.
4. Reddy, J.N. and Gartling, D.K “The Finite Element Method in Heat Transfer and Fluid Dynamics”, 2rd Ed., CRC Press. 2001.
5. Fish, J. and Belytschko, T., “A First Course in Finite Elements”, 1st Ed., John Wiley and Sons. 2007.
6. Chaskalovic, J., “Finite Element Methods for Engineering Sciences”, 1st Ed., Springer. 2008.
7. Bathe, K. J., “Finite Element Procedures”, 1st Ed., Cambridge Press.

CS561: Artificial Intelligence (3-0-0-6)
Prerequisite NIL

Introduction, Problem Solving: Uninformed search, Informed search, local Search, Online search; Knowledge and Reasoning: Building a Knowledge Base, Semantic Nets, Frames, First order logic, Inference in First Order Logic; Probabilistic Reasoning Systems: Bayes’ Nets; Learning: Learning from examples and analogy, Naive Bayes, Computational Learning Theory, Explanation Based Learning, Neural Networks; Evolutionary Optimization: Genetic algorithms, Multi objective optimization, Differential Evolution, Particle Swarm Optimization; Introduction to NLP; Introduction to Fuzzy sets.

References:

S. Russel and P. Norvig. Artificial Intelligence: A Modern Approach (Second edition), Pearson

E. Charniak, Introduction to Artificial Intelligence, Addison Wesley, 1985.

P. H. Winston, Artificial Intelligence, Addison Wesley, 1993.

E. Rich and K. Knight, Artificial Intelligence, Addison Wesley, 1990.

R.Honavar and E. Uhr, Artificial Intelligence and Neural Networks, Academic Press, 1992.

F. Hayes Roth, Building Expert Systems, Addison Wesley, 1983.

P. R. Cohen, The Handbook of Artificial Intelligence, Vol.1,2 and 3, Kaufman Inc.,1982.

B. K. P. Horn, Robot Vision, MIT Press, 1985. J. Carbonell, Machine Learning paradigms and Methods, MIT Press, 1990.

Journals:- Artificial Intelligence, AI Magazine, IEEE Expert, Machine Learning, Computer Vision Image Processing and Graphics, IEEE Transactions on Neural Networks.

EE501: Control of Mechatronic Systems (3-0-0-6)
Prerequisite NIL

Time response design: Routh-Hurwitz test, relative stability, Root locus design, construction of root loci, phase lead and phase-lag design, lag-lead design.

Frequency response design: Bode, polar, Nyquist, Nichols plot, lag, lead, lag-lead compensator, time delay, process plant response curve. PID controller design.
Modern control: Concept of states, state space model, different form, controllability, observability; pole placement by state feedback, observer design, Lunenburg observer, reduced order observer, observer based control.
Optimal control design: Solution-time criterion, control-area criterion, performance indices; zero steady state step error systems; modern control performance index: quadratic performance index, Ricatti equation.
Digital control: Sampling process, sample and hold, analog to digital converter, use of z-transform for closed loop transient response, stability analysis using bilinear transform and Jury method, digital control design using state feedback
Non-Linear Control System: Common physical non-linear system, phase plane method, system analysis by phase plane method, stability of non-linear system, stability analysis by describing function method, Liapunov's stability criterion, Popov's stability criterion.

Text Books:

1. K. Ogata, "*Modern Control Engineering*", Prentice Hall India (2002).
2. Gene F. Franklin, J. D. Powell, A E Naeini, "*Feedback Control of Dynamic Systems*", Pearson (2008).
3. John Van De Vegte, "*Feedback Control Systems*", Prentice Hall (1993).
4. Thomas Kailath, "*Linear Systems*", Prentice Hall (1980).
5. Alok Sinha, "*Linear Systems: Optimal and Robust Control*", Taylor & Francis (2007).
6. Brian D. O. Anderson and John B. Moore, "*Optimal Control: Linear Quadratic Methods*", Dover Publications (2007).
7. K. Ogata, "*Discrete-Time Control Systems*", PHI Learning (2009).
8. H.K. Khalil, "*Nonlinear Systems*", Prentice Hall (2001).

EE503 : Signal Processing in Mechatronics Systems (3-0-0-6)

Discrete- Time Signals: Sequences; representation of signals on orthogonal basis; Sampling and Reconstruction of signals
Discrete systems: Z-Transform, Analysis of LSI systems, Frequency Analysis, Inverse Systems, Discrete Fourier Transform (DFT), Fast Fourier Transform algorithm, Implementation of Discrete Time Systems.
Frequency selective filters: Ideal filter characteristics, lowpass, highpass, bandpass and bandstop filters, Paley-Wiener criterion, digital resonators, notch filters, comb filters, all-pass filters, inverse systems, minimum phase, maximum phase and mixed phase systems.
Design of FIR and IIR filters: Design of FIR filters using windows, frequency sampling, Design of IIR filters using impulse invariance, bilinear transformation and frequency transformations, Butterworth, Chebyshev Filters.
Introduction to multi-rate signal processing: Decimation, interpolation, polyphase decomposition; digital filter banks: Nyquist filters, two channel quadrature mirror filter bank and perfect reconstruction filter banks, subband coding.
Introduction to DSP Processors: Introduction to various Texas processors such as TMS320C6713, TMS320C6416, DM6437 Digital Video Development Platform with Camera, DevKit8000 OMAP3530 Evaluation

Kit.
Applications: Application of DSP to Speech and Radar signal processing,
A few case studies of DSP applications in multimedia using TI DSP kits.

Text books:

1. S. K. Mitra, Digital Signal Processing: A computer-Based Approach, 3/e, TMcHl, 2006.
2. A. V. Oppenheim and R. W. Shafer, Discrete-Time Signal Processing, Prentice Hall India, 2/e, 2004.
3. J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, 4/e, Pearson Education, 2007.

References:

1. V.K. Ingle and J.G. Proakis, "Digital signal processing with MATLAB", Cengage, 2008.
2. T. Bose, Digital Signal and Image Processing, John Wiley and Sons, Inc., Singapore,04.
3. L. R. Rabiner and B. Gold, Theory and Application of Digital Signal Processing, PH, 2005.
4. A. Antoniou, Digital Filters: Analysis, Design and Applications, Tata McH, 2003.

(Elective Courses) (Elective IV-VI)

ME502: Industrial Automation (3-0-0-6)

Prerequisite NIL

Unit 1: Automation: Introduction, automation principles and strategies, basic elements of advanced functions, levels modeling of manufacturing systems.

Unit 2: Material handling: Introduction, material handling systems, principles and design, material transport system: transfer mechanisms automated feed cut of components, performance analysis, uses of various types of handling systems including AGV and its various guiding technologies.

Unit 3: Storage system: Performance, location strategies, conventional storage methods and equipments, automated storage systems.

Unit 4: Automated manufacturing systems: Components, classification, overview, group technology and cellular manufacturing, parts classification and coding, product flow analysis, cellular manufacturing, application considerations in G.T.

Unit 5: FMS: Introduction, components, application, benefits, planning and implementation, transfer lines and fundamentals of automated production lines, application, analysis of transfer line without internal storage (numerical problems).

Unit 6: Inspection Technology: Introduction, contact and non-contact conventional measuring, gauging technique, CMM, surface measurement, machine vision, other optical inspection techniques, non-contact non-optical inspection technologies versus.

Unit 7: Manufacturing support system: Process planning and concurrent engineering- process planning, CAPP, CE and design for manufacturing, advanced manufacturing planning, production planning and control system, master production schedule, MRP.

Unit 8: Capacity planning, shop floor control, inventory control, MRP-II, J.I.T production systems. lean and agile manufacturing.

Text Books

1. M.P. Groover, Automation, "*Production Systems and Computer Integrated manufacturing*", 2nd Edition, Pearson Education (2004).

References Books

1. Vajpayee, "*Principles of CIM*", PHI, 1992.
2. Viswanathan and Narahari, "*Performance Modeling of Automated Manufacturing Systems*", PHI, 2000.

3. R.S. Pressman, “*Numerical Control and CAM*, John Wiley , 1993.

ME504 Vehicle Dynamics and Multi-body Systems (3-0-0-6)
Prerequisite NIL

Introduction to vehicle dynamics: Vehicle coordinate systems; loads on axles of a parked car and an accelerating car. Acceleration performance: Power-limited acceleration, traction-limited acceleration.
Tire models: Tire construction and terminology; mechanics of force generation; rolling resistance; tractive effort and longitudinal slip; cornering properties of tire; slip angle; camber thrust; aligning moments.
Aerodynamic effects on a vehicle: Mechanics of airflow around the vehicle, pressure distribution, aerodynamic forces; pitching, rolling and yawing moments; crosswind sensitivity.
Braking performance: Basic equations for braking for a vehicle with constant deceleration and deceleration with wind-resistance; braking forces: rolling resistance, aerodynamic drag, driveline drag, grade, tire-road friction; brakes, anti-lock braking system, traction control, braking efficiency.
Steering systems and cornering: Geometry of steering linkage, steering geometry error; steering system models, neutral steer, under-steer, over-steer, steering ratio, effect of under-steer; steering system force and moments, low speed and high speed cornering; directional stability of the vehicle; influence of frontwheel
drive.
Suspension and ride: Suspension types—solid axle suspensions, independent suspensions; suspension geometry; roll centre analysis; active suspension systems; excitation sources for vehicle rider; vehicle response properties, suspension stiffness and damping, suspension isolation, active control, suspension non-linearity, bounce and pitch motion.
Roll-over: Quasi-static roll-over of rigid vehicle and suspended vehicle; transient roll-over, yaw-roll model, tripping.
Multi-body systems: Review of Newtonian mechanics for rigid bodies and system of rigid bodies; coordinate transformation between two set of axes in relative motion between one another; Euler angles; angular velocity, angular acceleration, angular momentum etc. in terms of Euler angle parameters; Newton-Euler equations of motion; elementary Lagrangian mechanics: generalised coordinates and constraints; principle of virtual work; Hamilton’s principle; Lagrange’s equation, generalized forces. Lagrange’s equation with constraints, Lagrange’s multiplier.

Text Books

1. T.D. Gillespie, “*Fundamental of Vehicle Dynamics*”, SAE Press (1995).
2. J.Y. Wong, “*Theory of Ground Vehicles*”, 4th Edition, John Wiley & Sons (2008).
3. Reza N. Jazar, “*Vehicle Dynamics: Theory and Application*”, 1st Edition, 3rd Printing, Springer (2008).
4. R. Rajamani, “*Vehicle Dynamics and Control*”, Springer (2006).
5. A.A. Shabanna, “*Dynamics of Multibody Systems*”, 3rd Edition, Cambridge University Press (2005).

Reference Book

1. G. Genta, “*Motor Vehicle Dynamics*”, World Scientific Pub. Co. Inc. (1997).
2. H.B. Pacejka, “*Tyre and Vehicle Dynamics*”, SAE International and Elsevier (2005).
3. Dean Karnopp, “*Vehicle Stability*”, Marcel Dekker (2004).
4. U. Kiencke and L. Nielsen, “*Automotive Control System*”, Springer-Verlag, Berlin.
5. M. Abe and W. Manning, “*Vehicle Handling Dynamics: Theory and Application*”, 1st Edition, Elsevier (2009).

6. L. Meirovitch, "*Methods of Analytical Dynamics*", Courier Dover (1970).
7. H. Baruh, "*Analytical Dynamics*", WCB/McGraw-Hill (1999).

ME506: Emerging Smart Materials for Mechatronics Applications (3-0-0-6)
Prerequisite NIL

Introduction: Smart materials and their application for sensing and actuation, Mechatronics aspects

Piezoelectric materials: Piezoelectricity and piezoelectric materials, Constitutive equations of piezoelectric materials, Piezoelectric actuator types, Control of piezoelectric actuators, Applications of piezoelectric actuators for precise positioning and scanning.

Shape memory alloys (SMA): Properties of shape memory alloys, Shape memory effects, Pseudo-elasticity in SMA, Design of shape memory actuator, selection of materials, Smart actuation and control, Applications of SMA in precision equipments for automobiles, trains and medical devices

Electro-active polymers (EAPs): Ionic polymer metal composites (IPMC), Conductive polymers, Carbon nanotubes, Dielectric elastomers, Design & control issues for EAP actuators, Applications of EAP for biomemetic, tactile display and medical devices.

Magnetostrictive materials: Basics of magnetic properties of materials, magnetostriction: constitutive equations, types of magnetostrictive materials, Design & control of magnetostrictive actuators, Applications of magnetostrictive materials for active vibration control

Summary, conclusion and future outlook: Comparative analysis of different smart materials based actuators, Conclusions, Future research trend and applications trends of smart materials and smart materials based actuator technology.

Text books:

1. Jose L. Pons, Emerging Actuator Technologies, a Micromechatronics Approach, John Wiley & Sons Ltd, 2005
2. Ralph Smith, Smart Material Systems: Model Development, SIAM, Society for Industrial and Applied Mathematics, 2005
3. F. Carpi, D. De Rossi, R. Kornbluh, R. Pelrine, P. Sommer-Larsen, Dielectric Elastomers as Electromechanical Transducers, Elsevier, Hungry, 2008,
4. Y. B. Cohen, Electroactive Polymer (EAP) Actuators as Artificial Muscles Reality, Potential and Challenges, SPIE press, USA, 2004.

EE508 INTELLIGENT VISUAL SURVEILLANCE SYSTEMS 3-0-0-6

Basics of Image and Video Processing: Introduction to Image Processing methods, Image Transforms, Color spaces, An overview of Video Compression Standards: H. 261, H. 263, MPEG-1, MPEG-2, MPEG-4, MPEG-7, and MPEG-21, Video shot boundary detection.
Motion Analysis: Real versus apparent motion, Optical Flow Methods, Block Based Methods, Pel Recursive Methods, Mesh-based methods, Region-based (parametric), motion modeling, Categorization of motion segmentation technique.
Object Classification and Tracking- Shape based object classification, motion based object classification, Haar like feature based object detection, Viola Jones object detection framework, Multiclass classifier boosting.
Multi-Object Tracking- Video monitoring for detection and tracking of multiple interacting objects, Classification of multiple interacting objects from video, Region-based Tracking, Contour-based Tracking, Feature-based Tracking, Model-based Tracking, Hybrid Tracking, Particle filter based object tracking, Mean Shift based tracking.
Human Activity Recognition Techniques- Template based activity recognition, Hidden Markov Models (HMMs), Dynamic Time Warping (DTM), Finite-State Machine (FSM), Nondeterministic-Finite-State Automaton (NFA), Time-Delay Neural Network (TDNN), and Syntactic/Grammatical Techniques.
Camera Network Calibration - Types of CCTV (closed circuit television) camera- PTZ (pan-tilt zoom) camera, IR (Infrared) camera, IP (Internet Protocal) camera, wireless security camera, Multiple view geometry, camera network calibration, PTZ camera calibration, camera placement, smart imagers and smart cameras.
Security and Privacy of visual surveillance- Reliable visual data protection technique without sacrificing perceptual utility, secure authentication and privacy of visual surveillance.
Implementation of algorithms based on OpenCV (or Matlab) is covered in the course.
Text Books

1. Murat A. Tekalp, “Digital Video Processing”, Prentice Hall, 1995.
2. Y. Ma and G. Qian (Ed.), “Intelligent Video Surveillance: Systems and Technology”, CRC Press, 2009.
3. H. Aghajan and A. Cavallaro (Ed.), Multi-Camera Network: Principles and Applications”, Elsevier, 2009.
4. A senior (Ed.), “Privacy Protection in Video Surveillance”, Elsevier, 2009

Reference

1. Dr. Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer Publication, 2010

EE504: Microprocessor and Embedded Systems (3-0-0-6)

Introduction to Embedded Systems and microcomputers: Introduction to Embedded Systems, Embedded System Applications, Block diagram of embedded systems, Trends in Embedded Industry, Basic Embedded system Models, Embedded System development cycle, Challenges for Embedded system Design, Evolution of computing systems and applications. Basic Computer architecture: Von-Neumann and Harvard Architecture. Basics on Computer organizations. Computing performance, Throughput and Latency, Basic high performance CPU architectures, Microcomputer applications to Embedded systems and Mechatronics.

Microprocessor: 8086 Microprocessor and its Internal Architecture, Pin Configuration and their functions, Mode of Operation, Introduction to I/O and Memory, Timing Diagrams, Introduction to Interrupts.

Microprocessor Programming: Introduction to assembly language, Instruction format, Assembly language programming format, Addressing mode, Instruction Sets, Programming 8086 microprocessor.

Microprocessor Interfacing: Introduction to interfacing, Memory Interfacing, Programmable Peripheral Interfacing, Programmable I/O, Programmable Interrupt Controller, Programmable Timers, Programmable DMA Controller, Programmable Key board Controller, Data acquisition Interfacing: ADC, DAC, Serial and parallel data Communication interfacing. **Microcontroller:** Introduction to Microcontroller and its families, Criteria for Choosing Microcontroller. Microcontroller Architecture, Programming model, Addressing modes, Instruction sets, Assembly and C programming for Microcontroller, I/O programming using assembly and C language, Interrupt Controller, I/O interfacing, Timers, Real Time Clock, Serial and parallel Communication protocols, SPI Controllers. LCD Controller.

Microcontroller Interfacing: Introduction to Microcontroller Interfacing and applications: case studies: Display Devices, controllers and Drivers for DC, Servo and Stepper Motor.

Introduction to Advanced Embedded Processor and Software: ARM Processor, Unified Model Language (UML), Embedded OS, Real Time Operating System (RTOS), Embedded C.

Microprocessor and Embedded system Laboratories: Basic assembly language programming implementation on Microprocessor and Microcontroller. Interfacing Displays, Key boards and sensors with Microprocessors and Microcontrollers, Data Acquisition using Microprocessor and Microcontroller, Implementation of Controlling schemes for DC, Servo, Stepper motor using assembly and C programming in microprocessors and Microcontrollers,

Books:

1. Introduction to Embedded Systems: Shibu K V, McGRAW Hill Publications.
2. Embedded Systems: Raj Kamal, TATA McGRAW Hill Publications
3. Computer System Architecture: M. Morris Mano.
4. 8086 Microprocessors and Interfacings: D. Hall, TATA McGRAW Hill
5. The Intel Microprocessors: B. Brey, Prentice Hall Publications.
6. PIC Microcontrollers and Embedded Systems: M. A. Mazidi, R.D. Mckinlay and D. Casey, Pearson Publications
7. Programming and Customizing the PIC Microcontroller: M. Predko, McGRAW Hill Publications.
8. Embedded C Programming and Microchip PIC: R. Barnett, L. O’Cull and S. Cox.