SYLLABUS

ROBOTICS & MECHATRONICS

Class		M.TECH	L	T	P	C
Semester/Year		I/I	3	-	-	3
Subject Name		FUNDAMENTALS OF MECHATRONICS				
Subject Code		MECRM20S101				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:-

1. To educate the student to understand the fundamentals of Micro Electro Mechanical Systems (MEMS).
2. To understand different materials used for MEMS, semiconductors and Solid mechanics to fabricate MEMS devices.
3. To study the various sensors and actuators, applications of MEMS.
4. To disciplines beyond Electrical and Mechanical.

Course Outcomes:-

Students will be able to:-

CO1: Understand characteristics and the components of mechatronics systems.
CO2: Discuss recent trends in Mechatronics.
CO3: Describe active & Passive electrical circuits.
CO4: Describe the techniques are of used to design a mechatronics process.
CO5: Suggest possible design solutions.

Unit	Syllabus	Periods
UNIT-I	Introduction: Definition of Mechatronics, Mechatronics in manufacturing, Products, and design. Comparison between Traditional and Mechatronics approach.	10
UNIT-II	Drives: stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by Camshafts, electronic cams, indexing Mechanisms, tool magazines, transfer systems.	10
UNIT-III	Probability, Random variables, Probability distribution and density functions, Joint density and conditional distribution, Functions of random variables and random vectors.	12
UNIT-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.	13

UNIT-V	Description of PID controllers, CNC machines and part programming, Industrial Robotics.	**10**
	Text Books: **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.	
	Reference Books: **1.** T.O. Boucher, Computer automation in manufacturing - an Introduction, Chappman and Hall, 1996. **2.** R. Iserman, Mechatronic Systems: Fundamentals, Springer, 1st Edition, 2005. **3.** Musa Jouaneh, Fundamentals of Mechatronics, 1st Edition, Cengage Learning, 2012.	

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SCHOOL OF ENGINEERING

SYLLABUS

ROBOTICS & MECHATRONICS

Class		M.TECH	L	T	P	C
Semester/Year		I/I	3	-	-	3
Subject Name		ADVANCED ENGINEERING MATHEMATICS				
Subject Code		MECRM20S102				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:

1. To give the students an understanding of foundational conceptsin linear algebra and random processes for use in control systems.
2. To understand Probability distribution, Complex Number Theory, Random variables.
3. study the various Numerical Technique, Statistical Methods.

Course Outcomes:

CO1: Apply matrix properties and functions to a given problem.
CO2: Acquire knowledge about vector spaces, eigen values an eigen vectors of linear operators.
CO3: Acquire knowledge about random variables, probability distribution of random variables and transformation of random variables.
CO4: Identify Differential Equations.
CO5: Complex Number Theory & Statistical Methods are very useful in the robotics designs.

Unit	Syllabus	Periods
UNIT-I	Linear Algebra: Matrix algebra; basis, dimension and fundamental subspaces; solvability of Ax = b by direct Methods; orthogonality and QR transformation; eigen values and eigenvectors, similarity transformation, singular value decomposition, Fourier series, Fourier Transformation, FFT.	11
UNIT-II	Vector Algebra & Calculus: Basic vector algebra; curves; grad, div, curl; line, surface and volume integral, Green's theorem, Stokes's theorem, Gauss-divergence theorem.	9
UNIT-III	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.	13

UNIT-IV	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.	**12**
UNIT-V	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.	**14**
	Text Books: **1.** Higher Engineering Mathematics by B.V. Ramana, Tata Mc Hill. **2.** Advance Engineering Mathematics by Ervin Kreszig, Wiley Easten Edd. **3.** Numerical Solution of Differential Equation by M. K. Jain.	
	Reference Books: **1.** G. Strang, "Introduction to Linear Algebra", 4 th Edition, Wellesley-Cambridge Press, 2009. **2.** H. Kreyszig, "Advanced Engineering Mathematics", Wiley, (2006). **3.** J. W. Brown and R. V. Churchill, "Complex Variables and Applications", McGraw-Hill Companies, Inc., New York (2004). **4.** G. F. Simmons, "Differential Equations with Applications and Historical Notes", Tata McGraw-Hill Edition, India (2003). **5.** K. Atkinson and W. Han, "Elementary Numerical Analysis" 3rd edition, John Wiley & Sons, Inc., India (2004).	

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SCHOOL OF ENGINEERING

SYLLABUS

ROBOTICS & MECHATRONICS

Class		**M.TECH**	**L**	**T**	**P**	**C**
Semester/Year		**I/I**	**3**	**-**	**-**	**3**
Subject Name		**ROBOTICS: ADVANCED CONCEPTS AND ANALYSIS**				
Subject Code		**MECRM20S103**				
Paper	**English**					
	Hindi					
Max. Marks		**100**				

Course Objectives:

1. The course provides glimpses into the advanced methods of modeling and analysis of the dynamical systems.
2. The course is a strong step in inculcating the research aptitude in the students.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1: Acquire knowledge about the science and technology of robots.

CO2: Learn about different type of mathematical method generally used in robotics.

CO3: Describe the generation of symbolic equations of motion by a computer simulations of robots using software.

CO4: Understand Planning and control, Trajectory planning, position control.

CO5: Suggest possible design solutions.

Unit	Syllabus	Periods
UNIT-I	Introduction to robotics: brief history, types, classification and usage and the science and technology of robots.	**8**
UNIT-II	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.	**11**
UNIT-III	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.	**12**

UNIT-IV	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.	**14**
UNIT-V	Advanced topics in robotics: Modeling and control of flexible manipulators, wheeled mobile robots, bipeds, etc. Future of robotics.	**11**
	Text Books: **1.** S. K. Saha, "Introduction to Robotics", Tata McGraw-Hill Publishing Company Ltd. (2008). **2.** S. B. Niku, "Introduction to Robotics–Analysis systems, Applications", Pearson Education (2001). **3.** A. Ghosal, Robotics: "Fundamental Concepts and Analysis", Oxford University Press (2008).	
	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.** Pires, "Industrial Robot Programming–Building Application for the Factories of the Future", Springer (2007). **3.** Peters, "Image Guided Interventions – Technology and Applications", Springer (2008). **4.** K. S. Fu, R. C. Gonzalez and C.S.G. Lee, "ROBOTICS: Control, Sensing, Vision and Intelligence", McGraw-Hill (1987). **5.** J. J. Craig, "Introduction to Robotics: Mechanics and Control", 2nd edition, Addison-Wesley (1989).	

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SCHOOL OF ENGINEERING

SYLLABUS

ROBOTICS & MECHATRONICS

Class		M.TECH	L	T	P	C
Semester/Year		I/I	3	-	-	3
Subject Name		COMPUTATIONAL FLUID DYNAMICS				
Subject Code		MECRM20S104				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:

1. The primary objective of the course is to teach fundamentals of computational method for solving non-linear partial differential equations (PDE) primarily in complex geometry.
2. The emphasis of the course is to teach CFD techniques for solving incompressible and compressible N-S equation in primitive variables, grid generation in complex geometry, transformation of N-S equation in curvilinear coordinate system and introduction to turbulence modeling.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1: The course provides the student with knowledge about computational methods with finite differences, finite volumes and finite elements for technical fluid flow problems.

CO2: The course gives the student insight about finite difference methods, with necessary boundary conditions, accuracy, stability.

CO3: The course should enable the student to give neccesary boundary conditions for elliptical, parabolic and hyperbolic partial differential equations, perform simple stabillity analysis for difference schemes.

CO4: The course should enable the student to give curvilinear grid and transformed equations.

CO5: The course should enable the student to give Lattice Boltzman and Molecular Dynamics.

Unit	Syllabus	Periods
UNIT-I	Concept of Computational Fluid Dynamics: Different techniques of solving fluid dynamics problems, their merits and demerits, governing equations of fluid dynamics and boundary conditions, classification of partial differential equations and their physical behavior, Navier-Stokes equations for Newtonian fluid flow, computational fluid dynamics (CFD) techniques, different steps in CFD techniques, criteria and essentialities of good CFD techniques.	12
UNIT-II	Finite Difference Method (FDM): Application of FDM to model problems, steady and unsteady problems, implicit and explicit approaches, errors and stability analysis, direct and iterative solvers. Finite Volume Method	12

	(FVM): FVM for diffusion, convection-diffusion problem, different discretization schemes, FVM for unsteady problems.	
UNIT-III	Prediction of Viscous Flows: Pressure Poisson and pressure correction methods for solving Navier- Stokes equation, SIMPLE family FVM for solving Navier-Stokes equation, modeling turbulence.	**11**
UNIT-IV	CFD for Complex Geometry: Structured and unstructured, uniform and non-uniform grids, different techniques of grid generations, curvilinear grid and transformed equations.	**12**
UNIT-V	Lattice Boltzman and Molecular Dynamics: Boltzman equation, Lattice Boltzman equation, Lattice Boltzman methods for turbulence and multiphase flows, Molecular interaction, potential and force calculation, introduction to Molecular Dynamics algorithms.	**13**
	Text Books: **1.** J. D. Anderson, "Computational Fluid Dynamics", McGraw-Hill Inc. (1995). **2.** S. V. Patankar, "Numerical Heat Transfer and Fluid Flow", Hemisphere Pub. (1980). **3.** K. Muralidhar, and T. Sundarajan, "Computational Fluid Flow and Heat Transfer", Narosa (2003). **4.** M. Peric and J. H. Ferziger, "Computational Methods for Fluid Dynamics", Springer (2001).	
	Reference Books: **1.** Numerical Heat Transfer and Fluid Flow by S. V. Patankar (Hemisphere Series on Computational Methods in Mechanics and Thermal Science). **2.** Essential Computational Fluid Dynamics by Zikanov. O., Wiley 2010. **3.** Computer Simulation of Flow and Heat Transfer by P. S. Ghoshdastidar (4th Edition, Tata McGraw-Hill), 1998. **4.** Benjamin C. Kuo, Digital Control Systems, 2/e, Saunders College Publishing, Philadelphia, 1992.	

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SCHOOL OF ENGINEERING

SYLLABUS

ROBOTICS & MECHATRONICS

Class		M.TECH	L	T	P	C
Semester/Year		I/I	3	-	-	3
Subject Name		CONTROL OF MECHATRONIC SYSTEMS				
Subject Code		MECRM20S105				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:-

1. Aappreciate the need for feedback control in practical mechatronic systems.
2. Derive dynamical models and represent them in block diagram notation.
3. Analyse stability and performance of systems in the time and frequency domain using step and impulse responses, root-locus, Bode and Nyquist diagrams.

Course Outcomes:-

CO1: Identification of key elements of mechatronics system and its representation in terms of block diagram.
CO2: Understanding the concept of Frequency response design.
CO3: PID control implementation on real time systems.
CO4: Time and Frequency domain analysis of system model (for control application).
CO5: Development of PLC ladder programming and implementation of real life system.

Unit	Syllabus	Periods
UNIT-I	Time response design: Routh-Hurwitz test, relative stability, Root locus design, construction of root loci, phase lead and phase-lag design, lag-lead design.	9
UNIT-II	Frequency response design: Bode, polar, Nyquist, Nichols plot, lag, lead, lag-lead compensator, time delay, process plant response curve. PID controller design.	10
UNIT-III	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.	12
UNIT-IV	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.	13

UNIT-V	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.	**15**
	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.** K. Muralidhar, and T. Sundarajan, "Computational Fluid Flow and Heat Transfer", Narosa (2003). **4.** John Van De Vegte, "Feedback Control Systems", Prentice Hall (1993).	
	Reference Book(S):- **1.** Thomas Kailath, "Linear Systems", Prentice Hall (1980). **2.** Alok Sinha, "Linear Systems: Optimal and Robust Control", Taylor & Francis (2007). **3.** Brian D. O. Anderson and John B. Moore, "Optimal Control: Linear Quadratic Methods", Dover Publications (2007). **4.** K. Ogata, "Discrete-Time Control Systems", PHI Learning (2009). **5.** H.K. Khalil, "Nonlinear Systems", Prentice Hall (2001).	

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SCHOOL OF ENGINEERING

SYLLABUS

ROBOTICS & MECHATRONICS

Class		M.TECH	L	T	P	C
Semester/Year		I/I	3	-	-	3
Subject Name		SIGNAL PROCESSING IN MECHATRONICS SYSTEMS				
Subject Code		MECRM20S106				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:-

1. Appreciate the need for signal processing in practical mechatronic systems.
2. Derive dynamical models and represent them in block diagram notation.

Course Outcomes:-

CO1: Identification of key elements of mechatronics system and its representation in terms of block diagram.
CO2: Understanding the concept of Frequency selective filters.
CO3: Design of FIR and IIR filters.
CO4: Acquire knowledge about the uses of diffent type of filters.
CO5: Development of programming kits.

Unit	Syllabus	Periods
UNIT-I	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.	11
UNIT-II	Frequency selective filters: Ideal filter characteristics, low pass, high pass, band pass and band stop filters, Paley-Wiener criterion, digital resonators, notch filters, comb filters, all-pass filters, inverse systems, minimum phase, maximum phase and mixed phase systems.	10
UNIT-III	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.	11
UNIT-IV	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,	13

	subband coding.	
UNIT-V	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.	**14**
	Text Book(s):- **1.** S. K. Mitra, Digital Signal Processing: A computer-Based Approach, 3/e, TMc Hl, 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.	
	Reference Book(S):- **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.	

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SCHOOL OF ENGINEERING

SYLLABUS

ROBOTICS & MECHATRONICS

Class		**M.TECH**	**L**	**T**	**P**	**C**
Semester/Year		**I/I**	**-**	**-**	**4**	**2**
Subject Name		**MECHATRONICS LAB- I**				
Subject Code		**MECRM20S107**				
Paper	**English**					
	Hindi					
Max. Marks		**50**				

MECHATRONICS LAB- I

List of Experiments:

1. Demonstration Of Mechatronics Hardwares;
2. Servo- Position And Velocity Control;
3. Process Control; Basic Programming Using Microprocessor/Microcontroller;
4. ADC And DAC Interfacing With Microcontroller/Microprocessor;
5. Machine Condition Monitoring; Development Of Multiple Sensor Fusion;
6. Image Based Navigation And Control Of Robot;
7. Control Of Non-Linear Systems; Machine Vision Inspection And Image Surveillance;
8. Mini-Projects on Mechatronic System Design.

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SCHOOL OF ENGINEERING

SYLLABUS

CONTROL SYSTEM

Class		**M.TECH**	**L**	**T**	**P**	**C**
Semester/Year		**I/I**	**2**	**-**	**-**	**-**
Subject Name		**English for Research Paper Writing**				
Subject Code		**MECRM20S108**				
Paper	**English**					
	Hindi					
Max. Marks		**-**				

Course Objectives:

1. The aim of the course is to improve competence in scholarly communications by deepening knowledge of the core features of the scientific writing style.
2. In particular, they will develop an awareness of fundamental concepts of academic writing, such as contrastive rhetoric, logical organization, and argumentation.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1: Understand Planning and Preparation.
CO2: Understand about Paraphrasing and Plagiarism, Sections of a Paper.
CO3: Understand that which type of key skills needed when writing different type of headings.
CO4: Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission.
CO5: Learn about what to write in each section.

Unit	Syllabus	Periods
UNIT-I	Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.	**8**
UNIT-II	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction, Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	**9**
UNIT-III	Key skills needed when writing a Title, key skills needed when writing an Abstract, key skills Needed when writing an Introduction, skills	**11**

	needed when writing a Review of the Literature.	
UNIT-IV	Skills needed when writing the Methods, skills needed when writing the Results, skills needed when writing the Discussion, skills are needed when writing the Conclusions.	**13**
UNIT-V	Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.	**14**
	Text Books: **1.** Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press. **2.** Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook	
	Reference Books: **1.** Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books). **2.** Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London,2011.	

SYLLABUS

ROBOTICS & MECHATRONICS

Class		**M.TECH**	**L**	**T**	**P**	**C**
Semester/Year		**I/I**	**-**	**-**	**4**	**2**
Subject Name		**FUNDAMENTALS OF MECHATRONICS LAB**				
Subject Code		**MECRM20S109**				
Paper	**English**					
	Hindi					
Max. Marks		**50**				

FUNDAMENTALS OF MECHATRONICS LAB

List of Experiments:

1. Practical related to basic electrical and mechanical engineering, that is gives basic information about robotics, automation, and mechatronics.
2. Knowledge about basic mechanical, electrical and electronics parts.
3. Study about different types of sensors and actuators.
4. Study about interfacing between mechanical part to electrical and electronics systems.

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SCHOOL OF ENGINEERING

SYLLABUS

ROBOTICS & MECHATRONICS

Class		M.TECH	L	T	P	C
Semester/Year		I/I	2	-	-	2
Subject Name		Research Methodology and IPR				
Subject Code		MMAT20S111				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:

1. To explain various research designs and their characteristics.
2. To explain several parametric tests of hypotheses and Chi-square test.
3. To explain the art of interpretation and the art of writing research reports.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1: Understand research problem formulation.

CO2: Analyze research related information, applications, Follow research ethics.

CO3: Understand that today's world is controlled by Computer, Information Technology but tomorrow world will be ruled by ideas, concept, and creativity.

CO4: Understand Nature of Intellectual Property.

CO5: Understand that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.

Unit	Syllabus	Periods
UNIT-I	Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem. Scope and objectives of research problem, Approaches of investigation of solutions for research problem, data collection, analysis, interpretation.	10
UNIT-II	Effective literature studies approaches, analysis lagiarism, Research ethics.	8
UNIT-III	Effective technical writing, how to write report, Pape developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.	10

UNIT-IV	Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	**15**
UNIT-V	Frequency Domain Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	**15**
	Text Books: **1.** Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'" **2.** Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction".	
	Reference Books: **1.** Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016. **2.** Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007. **3.** T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008. **4.** Ranjit Kumar, 2nd Edition , "Research Methodology: A Step by Step Guide for beginners".	

SYLLABUS

ROBOTICS & MECHATRONICS

Class		**M.TECH**	**L**	**T**	**P**	**C**
Semester/Year		**II/I**	**3**	**-**	**-**	**3**
Subject Name		**Sensors and Actuators**				
Subject Code		**MEXCS20S201**				
Paper	**English**					
	Hindi					
Max. Marks		**100**				

Course Objectives:

1. The first objective of this course is to understand basics of sensors, actuators and their operating principle.
2. To study the various sensors and actuators, applications of MEMS to disciplines beyond Electrical and Mechanical.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1: Use concepts in common methods for converting a physical parameter into an electrical quantity.
CO2: Design and develop sensors using optical methods with desired properties.
CO3: Choose an appropriate sensor comparing different standards and guidelines to make sensitive measurements of physical parameters like pressure, flow, acceleration, etc.
CO4: Evaluate performance characteristics of different types of actuator.
CO5: Learn about Electrical actuating systems.

Unit	Syllabus	Periods
UNIT-I	Sensor fundamentals and characteristics, Sensor Classification: Position, Direction, Displacement and Level sensors Performance and Types, Error Analysis characteristics.	**8**
UNIT-II	Optical Sources and Detectors: Electronic and Optical properties of semiconductor as sensors, LED, Semiconductor lasers, Fiber optic sensors, Thermal detectors, Photo multipliers, photoconductive detectors, Photo diodes, Avalanche photodiodes, CCDs. Brief overview of measurement systems, classification, characteristics and calibration of different sensors.	**13**
UNIT-III	Strain gages, strain gage beam force sensor, piezoelectric force sensor, load cell, torque sensor, Piezo-resistive and capacitive pressure sensor, optoelectronic pressure sensors, vacuum sensors.	**11**

UNIT-IV	Actuators, definition, example, types, selection. Pneumatic actuator, Electro Pneumatic actuator. Hydraulic actuator, control valves, valve sizing valve selection.	**12**
UNIT-V	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.	**14**
	Text Books: **1.** John G. Webster, Editor-in-chief, "Measurement, Instrumentation, a Sensors Handbook", CRC Press (1999). **2.** Jacob Fraden, "Handbook of modern Sensors", AIP Press, Woodbury (1997). **3.** Nadim Maluf, "An Introduction to Micro electro-mechanical Systems Engineering", Artech House Publishers, Boston (2000). **4.** B. G. Liptak, "Instrument Engineers' Handbook: Process Measurement and Analysis", CRC (2003).	
	Reference Books: **1.** Marc Madou, "Fundamentals of Micro fabrication", CRC Press, Boca Raton (1997). **2.** Gregory Kovacs, "Micro machined Transducers Sourcebook", McGraw-Hill, New York (1998). **3.** E. O. Deobelin and D. Manik, "Measurement Systems – Application and Design", Tata McGraw-Hill (2004). **4.** D. Patranabis, "Principles of Industrial Instrumentation", Tata McGraw-Hill, eleventh reprint (2004).	

EKLAVYA UNIVERSITY
ज्ञान प्राप्तये लक्ष्य संधानम्
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SCHOOL OF ENGINEERING

SYLLABUS

ROBOTICS & MECHATRONICS

Class		M.TECH	L	T	P	C
Semester/Year		II/I	3	-	-	3
Subject Name		Modeling And Simulation of Mechatronic Systems				
Subject Code		MECRM20S202				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:

1. This course is designed to Introduce students to modern approaches to modeling and simulation of engineering dynamic systems.
2. Provide skills enabling students to carry the modeling-simulation-model validation cycle required in mechatronics system design.

Course Outcomes:

Students will be able to:-

CO1: Develop a simulation model for simple physical systems and explain mechatronics design process.
CO2: Outline appropriate sensors and actuators for an engineering application.
CO3: Write simple microcontroller programs.
CO4: Explain linearization of nonlinear systems and elements of data acquisition.
CO5: Explain various applications of design of mechatronic systems.

Unit	Syllabus	Periods
UNIT-I	Physical Modeling: Mechanical and electrical systems, physical laws, continuity equations, compatibility equations, system engineering concept, system modeling with structured analysis, modeling paradigms for mechatronic system, Block diagrams.	10
UNIT-II	Mathematical models, systems of differential-algebraic equations, response analysis of electrical systems, thermal systems, fluid systems, mechanical rotational system, electrical-mechanical coupling.	11
UNIT-III	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.	11

UNIT-IV	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, modeling of sensors and actuators, hardware in the loop simulation (HIL), rapid controller prototyping.	**15**
UNIT-V	Simulation and block diagrams, analogies and impedance diagrams, electrical systems, mechanical translational systems, mechanical rotational systems, electro mechanical coupling, fluid systems coupling of simulation tools, simulation of systems in software (MATLAB, Lab-VIEW) environment.	**14**
	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).	
	Reference Books: **1.** G. Gordon, "System Simulation", 2nd Edition, PHI Learning (2009). **2.** V. Giurgiutiu and S. E. Lyshevski, "Micromechatronics, Modeling, Analysis, and Design with MATLAB", 2nd Edition, CRC Press (2009).	

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SCHOOL OF ENGINEERING

SYLLABUS

ROBOTICS & MECHATRONICS

Class		M.TECH	L	T	P	C
Semester/Year		II/I	3	-	-	3
Subject Name		Non Linear Optimization				
Subject Code		MECRM20S203				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:

1. Demonstrate knowledge and understanding of nonlinear programming modelling techniques.
2. Demonstrate knowledge and understanding of nonlinear programming solution algorithms.
3. Optimization problems arise in a variety of disciplines, for e.g., machine learning, reinforcement learning, signal processing, networks.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1 Describe non-linear programming problems.

CO2: Distinguishes non-linear programming and linear programming problems.

CO3: Understand necessary and sufficient conditions to solve unconstrained problems.

CO4: Understand approximate solutions of restricted problems.

CO5: Understand and applies the non-linear programming software.

Unit	Syllabus	Periods
UNIT-I	Nonlinear programming: Convex sets and convex functions, their properties, convex programming problem, generalized convexity, Pseudo and Quasi convex functions, Invex functions and their properties, KKT conditions.	10
UNIT-II	Goal Programming: Concept of Goal Programming, Model Formulation, Graphical solution method. Separable programming.	9
UNIT-III	Geometric programming: Problems with positive coefficients up to one degree of difficulty, Generalized method for the positive and negative coefficients.	10
UNIT-IV	Search Techniques: Direct search and gradient methods, Unimodal functions, Fibonacci method, Golden Section method, Method of steepest	13

	descent, Newton-Raphson method, Conjugate gradient methods.	
UNIT-V	Dynamic Programming: Deterministic and Probabilistic Dynamic Programming, Discrete and continuous dynamic programming, simple illustrations. Multi objective Programming: Efficient solutions, Domination cones.	**15**
	Text Books: **1.** Mokhtar S. Bazaaraa, Hanif D. Shirali and M.C.Shetty, Nonlinear Programming, Theory and Algorithms, John Wiley & Sons, New York (2004). **2.** D. G. Luenberger, Linear and Nonlinear Programming, Second Edition, Addison Wesley (2003).	
	Reference Books: **1.** D. G. Luenberger, Linear and Nonlinear Programming, Second Edition, Addison Wesley (2003). **2.** R. E. Steuer, Multi Criteria Optimization, Theory, Computation and Application, John Wiley and Sons, New York (1986).	

SYLLABUS

ROBOTICS & MECHATRONICS

Class		M.TECH	L	T	P	C
Semester/Year		II/I	3	-	-	3
Subject Name		MEMS and NEMS				
Subject Code		MECRM20S204				
Paper	English					
	Hindi					
Max. Marks		100				

Course Objectives:

1. Have a concept on the scope and recent development of the science and technology of micro- and nano-systems.
2. Gain the physical knowledge underlying the operation principles and design of microand nano-systems.
3. Learn some typical or potentially applicable micro- and nano-systems at the frontier of the development of the field.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1 Understand the operation of micro devices, micro systems and their applications.

CO2: Design the micro devices, micro systems using the MEMS fabrication process.

CO3: Gain a knowledge of basic approaches for various sensor design.

CO4: Develop experience on micro/nano systems for photonics.

CO5: Gain the technical knowledge required for computer-aided design, fabrication, analysis and characterization of nano-structured materials, micro- and nano-scale devices.

Unit	Syllabus	Periods
UNIT-I	Overview And Introduction of Micro and Nano scale systems Introduction to Design of MEMS and NEMS, Overview of Nano and Micro electromechanical Systems, Applications of Micro and Nano electro mechanical systems, Micro electromechanical systems, devices and structures Definitions, Materials for MEMS: Silicon, silicon compounds, polymers, metals.	15
UNIT-II	MEMS fabrication technologies: Microsystems fabrication processes: Photolithography, Ion Implantation, Diffusion, and Oxidation. Thin film	13

	depositions: LPCVD, Sputtering, Evaporation, Electroplating; Etching techniques: Dry and wet etching, electrochemical etching; Micromachining: Bulk Micromachining, Surface Micromachining, High Aspect-Ratio (LIGA and LIGA-like) Technology; Packaging: Microsystems packaging, Essential packaging technologies, Selection of packaging materials.	
UNIT-III	Micro sensors, MEMS sensors: Design of Acoustic wave sensors, resonant sensor, Vibratory gyroscope, Capacitive and Piezo Resistive Pressure sensors- engineering mechanics behind these Micro sensors. Case study: Piezo-resistive pressure sensor.	**12**
UNIT-IV	Micro actuators design of actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces (Parallel plate, Torsion bar, Comb drive actuators), Micromechanical Motors and pumps. Case study: Comb drive actuators.	**13**
UNIT-V	Nano systems and quantum mechanics : Atomic Structures and Quantum Mechanics, Molecular and Nanostructure Dynamics: Shrodinger Equation and Wave function Theory, Density Functional Theory, Nanostructures and Molecular Dynamics, Electromagnetic Fields and their quantization, Molecular Wires and Molecular Circuits.	**14**
	Text Books: **1.** Electromechanical Sensors and Actuators, Ilene J. Busch-Vishniac, Springer, 2008. **2.** Introduction to Microelectronics Fabrication, Vol. V, G. W. Neudeck and R. F. Pierret (eds.), Addison Wesley, 1988. **3.** Introduction to Micro electromechanical Microwave Systems, H. J. De Loss Santos, 2nd edition, Norwood, MA: Artech,2004. **4.** Microsystems Design, S. D. Senturia, Kluwer – Academic Publishers, Boston MA, 2001.	
	Reference Books: **1.** Carbon Nanotubes and Related Structures, P. J. F. Harris, Cambridge University Press, UK, 1986. **2.** Carbon Nanoforms and Applications, M Sharon and M. Sharon, Mc Graw Hill, 2010. **3.** VLSI Technology, S. M. Sze (eds.), Mc-Graw Hill, NY, 1983. **4.** Quantum Phenomena, S. Datta, Addison – Wesley, 1989.	

EKLAVYA UNIVERSITY
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SCHOOL OF ENGINEERING

SYLLABUS

ROBOTICS & MECHATRONICS

Class		**M.TECH**	**L**	**T**	**P**	**C**
Semester/Year		**II/I**	**3**	**-**	**-**	**3**
Subject Name		**INDUSTRIAL AUTOMATION**				
Subject Code		**MECRM20S205**				
Paper	**English**					
	Hindi					
Max. Marks		**100**				

	Course Objectives: **1.** The aim of this course is to introduce students with present Industrial Automation scenario in India. **2.** The broad knowledge of essential component of present industrial Automation Industry such as Programmable Logic Controller (PLC), Distributed Control System (DCS), Supervisory Control and Data Acquisition (SCDA), industrial drives, human machine interface will enable the students to maintain the above automation controls systems used in the present industry.	
	Course Outcomes: Upon completion of the course, the students will be able to: **CO1** Describe working of various blocks of basic industrial automation system. **CO2:** Connect the peripherals with the PLC. **CO3:** Use various PLC functions and develop small PLC programs. **CO4:** Summarize Distributed control system and SCADA system. **CO5:** Use various industrial motor drives for the Industrial Automation.	
Unit	**Syllabus**	**Periods**
UNIT-I	PLC Basics: Need and benefit of automation, applications of PLC, PLC modules, I/O module, Communication module, PID module, Input analog and digital devices, Output analog and digital devices.	**9**
UNIT-II	PLC Functions: PLC registers, PLC timer function, PLC counter function, PLC simple arithmetic and logical functions, PLC ladder logic diagram, Advanced PLC functions like SKIP, MASTER CONTROL RELAY,	**11**

	JUMP with non return, jump with return, Sequencer function.	
UNIT-III	PLC Programming and Applications: PLC application: Bottling filling plant, Material handling elevator,2-axis robot with sequencer control, Level control, Troubleshooting Micro sensors.	**10**
UNIT-IV	DCS and SCADA: Introduction to DCS, concept of DCS, hierarchy of DCS, functions of each level of DCS. Introduction to supervisory Control and Data Acquisition system (SCADA), SCADA Architecture, Interfacing SCADA with.	**13**
UNIT-V	Industrial Drives: Introduction motor drive: V/F Control, Direct torque control, Stepper motor. drives, AC and DC Servo motor drives, DC motor.	**13**
	Text Books: 1. M.P. Groover, Automation, "Production Systems and Computer Integrated manufacturing", 2nd Edition, Pearson Education (2004). 2. Vajpayee, "Principles of CIM", PHI, 1992. 3. Viswanathan and Narahari, "Performance Modeling of Automated Manufacturing Systems", PHI, 2000.	
	Reference Books: 1. R.S. Pressman, "Numerical Control and CAM, John Wiley , 1993. 2. PLCs & SCADA: Theory and Practice Rajesh Mehra and Vikrant Vij Laxmi Publications, New Delhi, Latest edition. 3. Programmable Logic Controllers Bolton W. Elsevier India Pvt. Ltd. New Delhi.	

ABUS

ROBOTICS & MECHATRONICS

Class		M.TECH	L	T	P	C
Semester/Year		II/I	3	-	-	3
Subject Name		Vehicle Dynamics and Multi-body Systems				
Subject Code		MECRM20S206				
Paper	English					
	Hindi					
Max. Marks		100				

	Course Objectives: **1.** Multi body dynamics is an advanced set of tools for designing and optimizing multi body structural mechanics systems using Kinematics of Mechanisms. **2.** The aim of this course is to introduce students with basic knowledge of the theory of machines can take up this course, to enhance their knowledge in the domain of MBD and also apply for Multibody Dynamics Engineer in OEMs.	
	Course Outcomes: Upon completion of the course, the students will be able to: **CO1**: Formulate a model and free body diagram of multibody systems. **CO2:** Incorporate holonomic and nonholonomic constraints into a multibody system. **CO3:** Simulate the motion of a multibody system with a computer. **CO4:** Interpret and analyze the results of simulation. **CO5:** Understand and explain notable dynamic phenomena.	
Unit	**Syllabus**	**Periods**
UNIT-I	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.	**13**
UNIT-II	Aerodynamic effects on a vehicle: Mechanics of airflow around the vehicle, pressure distribution, aerodynamic forces; pitching, rolling and yawing moments; crosswind sensitivity.	**8**
UNIT-III	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	**15**

	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 front-wheel drive.	
UNIT-IV	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.	**14**
UNIT-V	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.	**14**
	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).	
	Reference Books: **1.** Reza N. Jazar, "Vehicle Dynamics: Theory and Application", 1st Edition, 3rd Printing, Springer (2008). **2.** R. Rajamani, "Vehicle Dynamics and Control", Springer (2006).	

Class		M.TECH	L	T	P	C
Semester/Year		II/I	-	-	4	2
Subject Name		MECHATRONICS LAB II				
Subject Code		MECRM20S207				
Paper	English					
	Hindi					
Max. Marks		50				

SYLLABUS

ROBOTICS & MECHATRONICS

MECHATRONICS LAB II

List of Experiments:

1. NC machine tool.
2. Sequence planning in CIM.
3. Automatic quality inspection in CIM.
4. Microprocessor/microcontroller based control.
5. 3 DOF gyroscope.
6. Design and fabrication of piezo-actuator.
7. Hydraulic actuator.
8. Pneumatic actuator.
9. Design and characterization of optical sensor.

SYLLABUS

ROBOTICS & MECHATRONICS

Class		M.TECH.	L	T	P	C
Semester/Year		II/I	-	-	4	2
Subject Name		Mini Project				
Subject Code		MECRM20S208				
Paper	English					
	Hindi					
Max. Marks:		50				

Course objective:

1. The students will be able to understand and apply the knowledge of management functions like planning, scheduling, executing and controlling to projects.

2. The students will be able to implement the safety aspects during the execution project.

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Recognize various engineering problems and techniques to solve them.

CO2: Reproduce the solution of the problems upon the need of society.

CO3: Cooperate to work within group.

CO4: Develop the writing and communication skills for various engineering problems.

CO5: Display lifelong learning.

Unit	Syllabus	Periods
	Mini Project will have mid semester presentation and end semester presentation. Mid semester presentation will include identification of the problem based on the literature review on the topic referring to latest literature available. End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals' contribution. Continuous assessment of Mini Project at Mid-Sem and End-Sem will be monitored by the departmental committee.	

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SCHOOL OF ENGINEERING

SYLLABUS

ROBOTICS & MECHATRONICS

Class		M.TECH.	L	T	P	C
Semester/Year		II/I	2	-	-	-
Subject Name		Stress Management by Yoga				
Subject Code		MECRM20S209				
Paper	English					
	Hindi					
Max. Marks:		-				

Course Objective:
After completing this module, you should be able to:
1. To achieve overall health of body and mind.
2. To overcome stress.

Course Outcomes:
After completion of course, students would be able to:
CO1: Develop healthy mind in a healthy body thus improving social health.
CO2: Improve efficiency.

Unit	Syllabus	Periods
UNIT-I	Definitions of Eight parts of yog. (Ashtanga)	8
UNIT-II	Yam and Niyam Do`s and Don’ts in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha. ii) Shaucha, santosh, tapa, swadhyay,is hwarpranidhan.	9
UNIT-III	Asan and Pranayam: - **i)** Various yog poses and their benefits for mind &body. **ii)**Regularization of breathing techniques and its effects-Types of pranayam.	11
	Reference Books: 1. Yogic Asanas for Group Tarining part- I Janardan Swami Yoga bhyasi Mandal Nagpur**.** 2. Rajayoga or conquering the Internal Nature” by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata.	

SYLLABUS

ROBOTICS & MECHATRONICS

Class		M.TECH	L	T	P	C
Semester/Year		II/I	-	-	4	2
Subject Name		MODELING AND SIMULATION OF MECHATRONIC SYSTEMS LAB				
Subject Code		MECRM20S210				
Paper	English					
	Hindi					
Max. Marks		50				

MODELING AND SIMULATION OF MECHATRONIC SYSTEMS LAB

List of Experiments:

1. Pure mechanical models.
2. Models for electromagnetic actuators including the electrical drivers.
3. Models for DC-engines with different closed loop controllers using operational amplifiers.
4. Models for transistor amplifiers.
5. Models for vehicle system.