Vidya Pratishthan's

Kamalnayan Bajaj Institute of Engineering and Technology, Baramati

(An Autonomous Institute)

Vidya Pratishthan's
Kamalnayan Bajaj Institute of Engineering & Technology

Syllabus Structure

M. Tech

(Robotics and Automation)

Department of Mechanical Engineering

(With effect from June 2023)

VP's Kamalnayan Bajaj Institute of Engineering and Technology, Baramati

Department of Mechanical Engineering

M. Tech- (Robotics and Automation)

(with effect from A.Y. 2023-24)

Semester I

Course Code	Course	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks						Credit Scheme	
		TH	PR	Activity	In-Sem	End-Sem	TW	PR	OR	Total	TH	PR
MRA23101	Advanced Mathematical Methods	4		20	30	60				110	04	
MRA23102	Robot Control System	4		20	30	60				110	04	
MRA23103	Robotics Based Industrial Automation	3		20	30	60				110	03	
MRA23104	MDS	2		10	20	40				70	02	
MRA23105	Research Methodology	3		10	30	60				100	03	
MRA23106	Laboratory Proficiency I		08				50		50	100		04
MHS23101	Indian Knowledge System	2		20					30	50	02	
	Total	**18**	**08**	**100**	**140**	**280**	**50**		**80**	**650**	**18**	**04**
Total Credit											22	

MDS

MRA23104-A	Service Robots	MRA23104-B	Wireless Networks
MRA23104-C	Signal Processing	MRA23104-D	Pneumatic and Hydraulic Control

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M. Tech- (Robotics and Automation)

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Semester II

Course Code	Course	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks						Credit Scheme	
		TH	PR	Activity	In-Sem	End-Sem	TW	PR	OR	Total	TH	PR
MRA23111	Robot Programming	04		20	30	60				110	04	
MRA23112	Advanced Robot kinematics and Dynamics	04		20	30	60				110	04	
MRA23113	Robot vision system	04		20	30	60				110	04	
MRA23114	Program Elective-I	04		20	30	60				110	04	
MRA23115	Laboratory Proficiency II		08				50		50	100		04
MSE23116	Environmental Studies	02		30					30	60	02	
	Tota l	**18**	**08**	**110**	**120**	**240**	**50**		**80**	**600**	**18**	**04**
Total Credit											22	

Program Elective I

MRA23114-A	Mechatronics Systems and Applications	MRA23114-B	Flexible Manufacturing Systems
MRA23114-C	Instrumentation and Sensors	MRA23114-D	CAD/CAM

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Semester III

Course Code	Course	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks						Credit Scheme	
		TH	PR	Activity	In-Sem	End-Sem	TW	PR	OR	Total	TH	PR
MRA23201	Artificial Intelligence in Robotics	04		20	30	60				110	04	
MRA23202	Soft Computing in Robotics	04		20	30	60				110	04	
MRA23203	Program Elective II	04		20	30	60				110	04	
MRA23204	Dissertation Stage I		08				100		50	150		04
MHS23201	Constitution of India	02		10					25	35	02	
MRA23205	Industrial Management	02		10					25	35	02	
	Total	**16**	**08**	**80**	**90**	**180**	**100**		**100**	**550**	**16**	**04**
Total Credit											**20**	

Program Elective II

MRA23203-A	Programming and Data Structure	MRA23203-B	MEMS and Microsystems
MRA23203-C	Mobile & Autonomous Robots	MRA23203-D	Simulation & Modelling

VP's Kamalnayan Bajaj Institute of Engineering and Technology, Baramati

Department of Mechanical Engineering

M. Tech- (Robotics and Automation)

(with effect from A.Y. 2023-24)

Semester IV

Course Code	Course	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks						Credit Scheme	
		TH	PR	Activity	In-Sem	End-Sem	TW	PR	OR	Total	TH	PR
MRA23211	Seminar		04				50		50	100		02
MRA23212	Industry Internship / Inhouse Research project		20				150		100	250		10
MRA23213	Dissertation Stage- II		16				100		100	200		08
	Total		**40**				**300**		**250**	**550**		**20**
Total Credit											**20**	

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MRA23101-Advanced Mathematical Methods

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	Activity Marks = 20 Marks
		In-sem-30 Marks
		End-sem-60 Marks

Unit 1: Numerical Methods (7)

Interpolation: Finite Differences, Newton's and Lagrange's Interpolation formulae, Numerical Differentiation.Numerical Integration: Trapezoidal and Simpson's rules, Bound of truncation error,

Unit 2: Numerical solutions of ordinary differential equations (7)

Taylor's series method, Euler's method, Modified Euler's method, Runge-Kutta method and Milne's Predictor-Corrector formula.

Unit 3: Partial Differential Equations (7)

Linear and non-linear partial differential equation and its classification, Solution of partial differential equations using Lagrange's method of undetermined multipliers and Charpit's Method.

Unit 4: Integral Equations (7)

Freedholm Integral Equation and its Classification, Volterra Integral Equation and its Classification, Singular Integral Equation.

Unit 5: Eigen Values & Eigen Functions (7)

Linear homogeneous Boundary Value Problems, Eigenvalues and Eigen functions, Sturm Liouville Boundary Value Problems, Non-homogeneous Boundary Value Problems.

Unit 6: Regression Analysis (7)

Correlation and Linear regression, Exponential regression, Introduction to multiple linear regression.

References:

1. Thomas G.B. & Finney R.L -Calculus & Analytic Geometry, Pearson Education, New Delhi, 2012.
2. Erwin K. -Advanced Engineering Mathematics, Wiley India Pvt. Ltd, New Delhi, 2012.
3. Rammana B.V. -Higher Engineering Mathematics Tata Mc-Graw-Hill 2012.
4. Numerical Methods for Engineers, Steven C Chapra & Raymond P Canale, TMH, Fifth Edition.
5. Applied Numerical Methods, Alkis Constantinides, McGraw Hill.
6. Numerical methods in Engineering and Science, Dr. B.S. Grewal, Khanna Publishers.
7. Elementary Differential Equations and Boundary Value Problems, Boyce and Diprime, Wiley, 2008.
8. Advanced Differential Equations, M. D. Raisinghania, S. Chand Publications, 2008.
9. Numerical Methods for Scientific and Engineering ComputationJain, M. K., Iyengar, S. R. K. and Jain, R. K., New Age Pvt. Pub, New Delhi. 2000.

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MRA23102-Robot Control system

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	Activity Marks = 20 Marks
		In-sem-30 Marks
		End-sem-60 Marks

Unit-I: Dynamics of Electromechanical Systems (7)

Basic Quantities: Elements and Basic Quantities in Mechanical Systems, Elements and Basic Quantities in Electric Systems, Fundamental Concepts of Mechanical Systems, The Principle of Least Action, Dynamics, Non- potential and Dissipative Forces, Equations of Motion, Properties of Equations of Motion, Operational Space Dynamics, Electric and Electromechanical Systems, Electrical Systems, Electromechanical Systems, Electrical Machines

Unit -II Control System Design (7)

Basic Concepts Basic Forms in Control Systems, Basic Relations, Stability, Sensitivity Function, External Inputs, State Space Representation: State Feedback, Stability, Observers, Systems with Observers, Disturbance Estimation, Dynamic Systems with Finite Time Convergence: Equivalent Control and Equations of Motion, Existence and Stability, Design, Control in Linear Systems, Sliding Mode Based Observers

Unit -III Acceleration Control (7)

Plant, Acceleration Control, Formulation of Control Tasks, Equivalent Acceleration and Equivalent Force, Enforcing Convergence and Stability, Convergence for Bounded Control Input, Systems with Finite-Time Convergence, Equations of Motion, General Structure of Acceleration Control, Trajectory Tracking

Unit -IV Disturbance Observers (7)

Disturbance Model Based Observers, Velocity Based Disturbance Observer, Position Based Disturbance Observer, Closed Loop Disturbance Observers, Internal and External Forces Observers, Observer for Plant with Actuator Plant with Neglected Dynamics of Current Control Loop, Plant with Dynamics in Current Control Loop, Estimation of Equivalent Force and Equivalent Acceleration, Functional Observers, Dynamics of Plant with Disturbance Observer, Disturbance Estimation Error, Dynamics of Plant With Disturbance Observer, Properties of Measurement Noise Rejection, Control of Compensated Plant

Unit-V Interactions and Constraints (7)

Interaction Force Control: Proportional Controller and Velocity Feedback, Environment with Losses, Lossless Environment, Control of Push Pull Force, Constrained Motion Control, Modification of Reference, Modification by Acting on Equivalent Acceleration, Motion Modification while Keeping Desired, Force Profile, Impedance Control, Force Driven Systems, Position and Force Control in Acceleration, Dimension, Interactions in Functionally Related Systems, Grasp Force Control , Functionally Related Systems.

Unit-VI Bilateral Control Systems (7)

Bilateral Control without Scaling, Bilateral Control Design, Control in Systems with Scaling in Position and Force, Bilateral Control Systems in Acceleration Dimension, Bilateral Systems with Communication Delay, Delay in Measurement Channel, Delay in Measurement and

Control Channels, Closed Loop Behavior of System with Observer, Bilateral Control in Systems with Communication Delay

References:

1. R Kelly, D. Santibanez, LP Victor and Julio Antonio, "Control of Robot Manipulators in Joint Space", Springer, 2005.
2. A Sabanovic and K Ohnishi, "Motion Control Systems", John Wiley & Sons (Asia), 2011.R M Murray, Z. Li and SS Sastry, "A Mathematical Introduction to Robotic Manipulation", CRC Press, 1994.
3. J J Craig, "Introduction to Robotics: Mechanics and Control", Prentice Hall, 2004.
4. J J E Slotine and W Li, "Applied Nonlinear Control", Prentice Hall, 1991.
5. Sebastian Thrun, Wolfram Burgard, Dieter Fox, "Probabilistic Robotics", MIT Press, 2005.
6. Carlos, Bruno, Georges Bastin, "Theory of Robot Control", Springer, 2012

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MRA23103-Robotics Based Industrial Automation

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 hrs/week	TH:3	Activity Marks = 20 Marks
		In-sem-30 Marks
		End-sem-60 Marks

Unit- I: Introduction **(8)**

Definition, automation principles and strategies, scope of automation, socio-economic consideration, low cost automation, basic elements of advanced functions, Information processing in manufacturing industry, Production concepts and automation strategies.
Fixed Automation: Automated Flow lines, Methods of Work part Transport, Transfer Mechanism - Continuous transfer, intermittent transfer, Indexing mechanism, Operator-Paced Free Transfer Machine, Buffer Storage, Control Functions, Automation for Machining Operations, Design and Fabrication Considerations.
Modeling Automated Manufacturing Systems: Role of Performance Modeling, Performance Measures, Performance Modelling Tools: Simulation Models, Analytical Models.

Unit- II: Introduction to Industrial Robots: **(8)**

Definitions, Types of Robots, Application of Robots, Representing Position and Orientation, Representing Pose in 2-Dimensions, Representing Pose in 3-Dimensions, Representing Orientation in 3-Dimensions, Combining Translation and Orientation.

Unit –III: Time and Motion **(8)**

Trajectories, Smooth One-Dimensional Trajectories, Multi-Dimensional Case, Multi-Segment Trajectories, Interpolation of Orientation in 3D, Cartesian Motion, Time Varying Coordinate Frames, Rotating Coordinate Frame, Incremental Motion, Inertial Navigation Systems. Mobile Robot Vehicles, Mobility, Car-like Mobile Robots, Moving to a Point, Following a Line, Following a Path, Moving to a Pose.

Unit –IV: Robot Arm Kinematics **(8)**

Describing a Robot Arm, Forward Kinematics, A 2-Link Robot, A 6- Axis Robot, Inverse Kinematics, Closed-Form Solution, Numerical Solution, Under-Actuated Manipulator, Redundant Manipulator, Trajectories, Joint-Space Motion, Cartesian Motion, Motion through a Singularity

Unit- V: Getting Started with ROS for Industrial Application: **(8)**

Installing ROS, Understanding the ROS Filesystem level, Packages, Stacks, Messages, Services, Understanding the ROS Computation Graph level, Nodes, Topics, Services, Messages, Bags, Master, Parameter Server, Creating workspace, Creating & Building an ROS package, Creating & Building the node, Visualization of images, Working with stereo vision, 3D visualization, Visualizing data on a 3D world using rviz

Unit –VI: Robot Programming for Industrial applications: **(8)**

Using Sensors and Actuators with ROS, SCORBOT structure, joint movements, work envelop, motors, encoders, microswitch, transmission, gripper, SCORBOT programming, IS-14533 : 2005 Manipulating industrial robots - Performance criteria related test methods, Mobile Robot

Programming, Industrial Robot Programming.
PLC: Introduction, Micro PLC, Programming a PLC, Logic Functions, Input & Output Modules,PLC Processors, PLC Instructions, Documenting a PLC System, Timer & Counter Instructions, Comparison & Data Handling Instructions, Sequencing Instructions, Mask Data Representation, Typical PLC Programming Exercises for Industrial Applications.

References:

1. M.P. Groover "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education.
2. Krishna Kant ,"Computer Based Industrial Control" –, EEE-PHI
3. Webb John Principles and Applications of PLC –, McMillan 1992
4. Tiess Chiu Chang & Richard A. Wysk "An Introduction to Automated Process Planning Systems"
5. Amber G.H & P.S. Amber "Anatomy of Automation", Prentice Hall.
6. Peter Corke Robotics, Vision and Control: Fundamental Algorithms in MATLAB® -, Springer Tracts in Advanced Robotics, Volume 73, 2011 2.
7. Aaron Martinez & Enrique Fernández ,Learning ROS for Robotics Programming, Packt Publishing
8. Yoram Koren , Robotics for Engineers -, McGraw Hill International, 1st edition, 1985.
9. M. Weiss, R. N. Nagel, M. P. Groover, Industrial Robotics , McGraw Hill International, 2nd edition, 2012.
10. Fu, Lee and Gonzalez. Robotics, control vision and intelligence- McGraw Hill International, 2nd edition, 2007.
11. John J. Craig , Introduction to Robotics-, Addison Wesley Publishing, 3rd edition, 2010.

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For

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MDS

MRA23104-A-Service Robots

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 2 hrs/week	TH: 2	Activity Marks- 10 Marks
		In-sem-20 Marks
		End-sem-40 Marks

Unit -I: Introduction (5)

History of service robotics – Present status and future trends – Need for service robots - Applications- Examples and Specifications of service and field Robots. Non-conventional Industrial robots the humanoid robots functions & its operations.

Unit- II: Localization (5)

Introduction-Challenges of Localization- Map Representation- Probabilistic Map based Localization- Monte carlo localization- Landmark based navigation-Globally unique localization- Positioning beacon systems- Route based localization.

Unit- III: Planning and Navigation (5)

Introduction-Path planning overview- Road map path planning- Cell decomposition path planning-Potential field path planning-Obstacle avoidance - Case studies: Tiered robot architectures.

Unit- IV: Field Robots (5)

Ariel robots- Collision avoidance-Robots for agriculture, mining, exploration, underwater,Civilian and military applications, Nuclear applications, Space applications.

Unit- V: Humanoids (5)

Wheeled and legged, Legged locomotion and balance, Arm movement, Gaze and auditory orientation control, Facial expression, Hands and manipulation, Sound and speech generation, Motion capture/Learning from demonstration, Human activity recognition using vision, touch, sound, Vision, Tactile Sensing, Models of emotion and motivation. Performance, Interaction, Safety and robustness, Applications- Case studies.

Unit - VI: Domestic and Medical Robotics (5)

Introduction to home automation, domestic robotics, cleaning robots, lawn moving robots, challenges and applications. Introduction to medical robotics, historical background, surgical robots, rehabilitation robots, exoskeletons, issues related to safety and ethics, applications and challenges in medical robotics.

References:

1. Roland Siegwart, Illah Reza Nourbakhsh, DavideScaramuzza, „Introduction to Autonomous Mobile Robots‖, Bradford Company Scituate, USA, 2004
2. Riadh Ziaer (Ed) „The future of Humanoid Robots- Research and applications", Intech Publications, 2012.
3. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India P Ltd., 2006.
4. Kelly, Alonzo; Iagnemma, Karl; Howard, Andrew, "Field and Service Robotics ", Springer, 2011

5. Groover M. P., "Industrial Robotics: Technology, Programming and Applications, Tata McGraw Hill Publication
6. Taghirad H.D, "Parallel Robots: Mechanics and Control", CRC Press.
7. Moore S. W., Bohm H., and ,Jensen V., "Underwater Robotics: Science, Design & Fabrication", Marine Advanced Technology Education (MATE) Center, 2010
8. Mejia O. D. M., Gomez J. A. E., (eds.), "Aerial Robots: Aerodynamics, Control and Application" InTech Open Publications.
9. Bock T., Linner T., "Robot Oriented Design: Design and Management Tools for the Deployment of Automation and Robotics in Construction", Cambridge University Press,
10. Robotics and Mechatronics for Agriculture, by Zhang D., Wei B., (eds.), CRC Press.
11. Medical Robotics, by Schweikard A., Ernst F., Springer Publications
12. Household Service Robotics, by Xu Y., Qian H., and Wu X., Zhejiang University Press.
13. Springer Handbook of Robotics, by Khatib O., (ed.), Springer Publications.
14. Humanoid Robotics: A Reference, Vadakkepat P., Goswami, A.,Springer Netherlands, 2017.
15. On Road Intelligent Vehicles, by Kala R., Elsevier Publications, 2017

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MDS

MRA23104-B-Wireless Networks

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 2 hrs/week	TH: 2	Activity Marks- 10 Marks
		In-sem-20 Marks
		End-sem-40 Marks

Unit- I : Wireless LAN **(5)**

Introduction-WLAN technologies: Infrared, UHF narrowband, spread spectrum -IEEE802.11: System architecture, protocol architecture, physical layer, MAC layer, 802.11b, 802.11a – Hiper LAN: WATM, BRAN, HiperLAN2 – Bluetooth: Architecture, Radio Layer, Baseband layer, Link manager Protocol, security - IEEE802.16-WIMAX: Physical layer, MAC, Spectrum allocation for WIMAX

Unit- II : Mobile Network Layer **(5)**

Introduction - Mobile IP: IP packet delivery, Agent discovery, tunnelling and encapsulation, IPV6-Network layer in the internet- Mobile IP session initiation protocol - mobile ad-hoc network: Routing, Destination Sequence distance vector, Dynamic source routing.

Unit- III: Mobile Transport Layer **(5)**

TCP enhancements for wireless protocols - Traditional TCP: Congestion control, fast retransmit/fast recovery, Implications of mobility - Classical TCP improvements: Indirect TCP, Snooping TCP, Mobile TCP, Time out freezing, Selective retransmission, Transaction oriented TCP - TCP over 3G wireless networks.

Unit- IV: Wireless Wide Area Network **(5)**

Overview of UTMS Terrestrial Radio access network-UMTS Core network Architecture: 3G-MSC, 3G-SGSN, 3G- GGSN, SMS-GMSC/SMS-IWMSC, Firewall, DNS/DHCP-High speed Downlink packet access (HSDPA)- LTE network architecture and protocol.

Unit- V: 4G Networks **(5)**

Introduction – 4G vision – 4G features and challenges - Applications of 4G – 4G Technologies: Multicarrier Modulation, Smart antenna techniques, OFDM-MIMO systems, Adaptive Modulation and coding with time slot scheduler, Cognitive Radio.

Unit- VI: 5G Networks **(5)**

5G Architecture: Software Defined Networking – Network Function Virtualization – Basics about RAN Architecture –High-Level Requirements for 5G Architecture – Functional Architecture and 5G Flexibility – Physical Architecture and 5G Deployment Millimeter Wave Communication: Channel Propagation – Hardware Technologies for mmWave Systems – Deployment Scenarios – Architecture and Mobility – Beamforming – Physical layer Techniques

References:

1. Next Generation Wireless LANs by EldadPerahia, Robert Stacey
2. Wireless Networks by Clint Smith and Daniel Collins
3. 802.11 Wireless Networks: The Definitive Guide, Second Edition
4. Designing and Deploying 802.11ac Wireless Networks by Jim Geier

5. Jochen Schiller, "Mobile Communications", Second Edition, Pearson Education 2012.(Unit I,II,III)
6. Vijay Garg , "Wireless Communications and networking", First Edition, Elsevier 2007.
7. Wireless Networking Absolute Beginner's Guide by Michael Miller
8. Computer Networking First-Step by Norman Laurence

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MDS

MRA23104-C-Signal Processing

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 2 hrs/week	TH: 2	Activity Marks- 10 Marks
		In-sem-20 Marks
		End-sem-40 Marks

Unit- I: Introduction to Signals & Systems **(5)**

Signals: Introduction, Graphical, Functional, Tabular and Sequence representation of Continuous and Discrete time signals. Basics of Elementary signals: Unit step, Unit ramp, Unit parabolic, Impulse, Sinusoidal, Real exponential, Complex exponential, Rectangular pulse, Triangular, Signum, Sinc and Gaussian function.
Operations on signals: time shifting, time reversal, time scaling, amplitude scaling, signal addition, subtraction, signal multiplication. Communication, control system and Signal processing examples.
Classification of signals: Deterministic, Random, periodic , Non periodic, Energy , Power, Causal , Non- Causal, Even and odd signal.
Systems: Introduction, Classification of Systems: Lumped Parameter and Distributed Parameter System, static and dynamic systems, causal and non-causal systems, Linear and Non- linear systems, time variant and time invariant systems, stable and unstable systems, invertible and non- invertible systems.

Unit- II: Time domain representation of LTI System **(5)**

Input-output relation, definition of impulse response, convolution sum, convolution integral, computation of convolution integral using graphical method for Unit step to Unit step, Unit step to exponential, exponential to exponential, Unit step to rectangular and rectangular to rectangular only. Computation of convolution sum. Properties of convolution. System interconnection, system properties in terms of impulse response, step response in terms of impulse response.

Unit- III: Fourier Series **(5)**

Fourier series (FS) representation of periodic Continuous Time (CT) signals, Dirichlet condition for existence of Fourier series, orthogonality, basis functions, Amplitude and phase response, FS representation of CT signals using trigonometric and exponential Fourier series. Applications of Fourier series, properties of Fourier series and their physical significance, Gibbs phenomenon.

Unit- IV: Fourier Transform **(5)**

Fourier Transform (FT) representation of a periodic CT signals, Dirichlet condition for existence of Fourier transform, evaluation of magnitude and phase response, FT of standard CT signals, Properties and their significance, Interplay between time and frequency domain using sinc and rectangular signals, Fourier Transform for periodic signals.DTFT, Definition, Frequency domain sampling , DFT, Properties of DFT, circular convolution, linear convolution.

Unit- V: Laplace Transform **(5)**

Definition of Laplace Transform (LT), Limitations of Fourier transform and need of Laplace transform, ROC, Properties of ROC, Laplace transform of standard periodic and aperiodic functions, properties of Laplace transform and their significance, Laplace transform evaluation using properties, Inverse Laplace transform based on partial fraction expansion, stability considerations in S domain, Application of Laplace transforms to the LTI system analysis.

Unit- VI :Application of Signal Processing in Robotics and Automation **(5)**

Applications of signal processing in robotic sectors: Autonomous navigation, robot teams or swarms of robots and target tracking. Remote health monitoring, neurobiological surveillance systems and fall detection for aged patients.

References:

1. Simon Haykins and Barry Van Veen, "Signals and Systems", Wiley India, 2 nd Edition.
2. M.J. Roberts "Signal and Systems", Tata McGraw Hill 2007.
3. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing: Principles, Algorithms and applications" Fourth edition, Pearson Prentice Hall.
4. S. Salivahanan, C. Gnanpriya, "Digital Signal processing", McGraw Hill
5. Charles Phillips, "Signals, Systems and Transforms", Pearson Education, 3 rd Edition.
6. Peyton Peebles, "Probability, Random Variable, Random Processes", Tata McGraw Hill, 4 th Edition.
7. A. Nagoor Kanni "Signals and Systems", McGraw Hill, 2 nd Edition
8. Dr. Shaila Apte, "Digital Signal Processing" Wiley India Publication, second edition
9. K.A. Navas, R. Jayadevan, "Lab Primer through MATLAB", PHI
10. Li Tan, Jean Jiang, "Digital Signal Processing: Fundamentals and applications" Academic press

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For

Head
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MDS

MRA23104-D-Pneumatic and Hydraulic Control

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 2 hrs/week	TH: 2	Activity Marks- 10 Marks
		In-sem-20 Marks
		End-sem-40 Marks

Unit- I: Fluid Power Principles and Hydraulic Pumps (5)

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids

Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory, Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps – Problems.

Unit- II: Hydraulic Actuators and Control Components **(5)**

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories : Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems.

Unit- III: Hydraulic Circuits and Systems **(5)**

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double- Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

Unit- IV: Pneumatic and Electro Pneumatic Systems **(5)**

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits.

Unit- V: Trouble Shooting and Applications **(5)**

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.

Unit –VI: Pneumatic Control Valves **(5)**

DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, Quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols. Simple Pneumatic Control:Direct and indirect actuation pneumatic cylinders, speed control of cylinders

- supply air throttling and Exhaust air throttling and Exhaust air throttling. Signal Processing Elements: Use of Logic gates - OR and AND gates in pneumatic applications. Practical

Examples involving the use of logic gates, Pressure dependant controls- types - construction - practical applications, Time dependent controls principle. Construction, practical applications.

References:

1. Anthony Esposito, "Fluid Power with Applications", Pearson Education 2005.
2. Majumdar S.R., "Oil Hydraulics Systems– Principles and Maintenance", Tata McGraw-Hill, 2001.
3. Anthony Lal, "Oil hydraulics in the service of industry", Allied publishers, 1982.
4. Dudelyt, A. Pease and John T. Pippenger, "Basic Fluid Power", Prentice Hall, 1987.
5. Majumdar S.R., "Pneumatic systems – Principles and maintenance", Tata McGraw Hill, 1995
6. Michael J, Prinches and Ashby J. G, "Power Hydraulics", Prentice Hall, 1989.
7. Shanmugasundaram.K, "Hydraulic and Pneumatic controls", Chand & Co, 2006.

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MRA23105-Research Methodology

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 hrs/week	TH:3	Activity Marks = 10
		In-sem-30 Marks
		End-sem-60 Marks

Unit –I: Introduction (7)

Nature and objectives of research. Methods of Research: historical, descriptive and experimental, research process, research approaches, criteria for good research, problems faced by researchers

Unit –II: Research Design (7)

Meaning of research design, need of research design, features of good design, different research designs, basic principles of experimental designs, design of experiments.

Unit-III: Data Collection (7)

Types of data, methods and techniques of data collection, primary and secondary data, meta analysis, historical methods, content analysis, devices used in data collection, pilot study and pretest of tools, choice of data collection methods.

Unit-VI: Processing and Analysis of Data (7)

Use of statistics for data analysis, measures of central tendency, dispersion, skewness and relationship. Sampling distributions, sampling theory, determination of sample size, chi-square test, analysis of variance, multiple regression analysis, neural networks.

Unit-V: Decision Making Techniques (7)

Multi-attribute decision making techniques: Analytical Hierarchy Process (AHP), TOPSIS, Data Envelope Analysis (DEA), graph theory and matrix approach.

Multi-objective decision making techniques: Simulated annealing, Genetic algorithms.

Unit-VI: Interpretation and Report Writing (7)

Techniques of interpretation, precautions in interpretation, significance of report writing, different steps in report writing, layout of research report, mechanics of writing research report.

References:

1. C.R Kothari "Research Methodology" Wishwa Prakashan, ISBN: 8173280363
2. P.G Triphati "Research Methodology" Sultan Chand & Sons, New Delhi.
3. J. W Barnes, "Statistical Analysis for Engineers and Scientists" McGraw Hill, New York.
4. Ranjit Kumar "Research Methodology" Pearson Education, ISBN: 9788131704967
5. Rao R. V. "Decision making in the manufacturing environment using graph theory and fuzzy multiple attribute decision making" Springer-Verlag, London. ISBN:

1846288193
6. Rao S. S., "Optimization", Wiley Eastern, New Delhi, 1995. ISBN: 0471550345
7. Montgomery D.C., "Design and analysis of experiments", John Wiley & Sons, ISBN: 0470128666.

Mrs. P.P.Kale
PG Coordinator

For Head
Department of Mechanical Engineering
VPKBIET Baramati-413133

MRA23106-Laboratory Proficiency I

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 8 hrs/week	PR:4	TW-50 Marks
		OR- 50 Marks

1. Industrial case study on design of experiment
2. Industrial case study on multi-attribute decision making
3. Numerical solution of a partial differential equation by using different methods
4. Manufacturing application of T test and Chi-square test.
5. Microcontroller lab – programming (free software /open source)
6. Integration of assorted sensors (IR, Potentiometer, strain gages etc.),
7. Micro controllers and ROS (Robot Operating System) in a robotic system. (Free software, Matlab)
8. Control experiment using available hardware or software. (Open source or Matlab).

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For

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VPKBIET Baramati-413133

MHS23101: Indian Knowledge System		
Teaching Scheme: **TH: 02 Hr./Week**	**Credit: 02**	**Examination scheme:** **Activity: 20 Marks** **Oral Exam: 30 marks**

Course Objectives:

1. To create awareness about the history and rich culture of the Bharata.
2. To introduce Vedic mathematics principles for faster calculations.
3. To know the science and Astronomy contributions of the traditional knowledge of Bhārata;
4. To learn engineering and technology contributions of the traditional knowledge of Bhārata;
5. To convert the Bhāratīya wisdom into the applied aspect of the modern scientific paradigm

Course Outcomes:

Students will be able to

CO1: Explain the historicity of Indian Knowledge System and the broad classification of Indian philosophical systems.

CO2: Apply Vedic Mathematics for faster calculations.

CO3: Understand the importance of science and astronomy concepts developed Bhārata;

CO4: To understand the contributions in the science, engineering & technology heritage of ancient and medieval India.

UNIT -I: Bhāratīya Civilization and Development of Knowledge System (4 hours)

Genesis of the land, Antiquity of civilization, the Saraswatī-Sindhu Civilization, Traditional Knowledge System, The Vedas, Main Schools of Philosophy, Ancient Education System, the Takṣaśilā University, the Nālandā University, Knowledge Export from Bhārata. Ethnic Studies, Life Science studies, Agriculture, Ecology and Environment, Āyurveda, Integrated Approach to Healthcare, Medicine, Microbiology, Surgery, and Yoga.

UNIT-II: Vedic Mathematics (8 hours)

Indian Mathematicians, Varahmihir, Brahmagupta, Srinivasa Ramanujan, Neelkanth Somayya, Bharti Krishna Tirtha, Introduction to sutras, and sub sutras,

Methods for Addition, Multiplication, division, squaring and square roots, cube and cube roots, Factorization. Differentiation and Integration methods

Easy Solution of linear equations: Introduction of simple equation, Solutions of simple equations, Solutions of linear equations in two variables, Practical application of linear equations in two variables, Quadratic equations

High-Speed Matrix Algebra: Introduction and history of Matrices and Determinants, Matrices and Determinants of third order, Inverse of Matrices,

Vedic Geometry: Different forms of straight lines, The Triangle, The Cyclic Quadrilateral, Squares, and the Circle, Geometrical constructions (such as Altars), Transformation of simple shapes, Kalpa Sutras-Srautha Sutras and Sulbha Sutras

UNIT-III: Science, Astronomy (4 hours)

Concept of Matter, Life and Universe, Gravity, Sage Agastya's Model of Battery, Velocity of Light, Vimāna: Aeronautics, Vedic Cosmology and Modern Concepts, Bhāratīya Kāla-gaṇanā, History and Culture of Astronomy, Sun, Earth, Moon, and Eclipses, Earth is Spherical and Rotation of Earth, Archaeoastronomy.

UNIT-IV: Engineering, Technology, and Architecture (4 hours) Pre-Harappan and Sindhu Valley Civilization, Laboratory and Apparatus, Juices, Dyes, Paints and Cements, Glass and Pottery, Metallurgy, Engineering Science and Technology in the Vedic Age and Post-Vedic Records, Iron Pillar of Delhi, Rakhigarhi, Mehrgarh, Sindhu Valley Civilization, Marine Technology, and Bet–Dwārkā.

Textbooks:

1. Textbook on The Knowledge System of Bhārata by Bhag Chand Chauhan,
2. Engineering and Technology in Ancient India by Ravi Prakash Arya
3. History of Science in India Volume-1, Part-I, Part-II, Volume VIII, by Sibaji Raha, et al. National Academy of Sciences, India and The Ramakrishna Mission Institute of Culture, Kolkata (2014).
4. Science and Technology in Ancient Indian Texts by Bal Ram Singh, Nath Girish, Umesh Kumar Singh
5. Vedic Mathematics, Swami Bharati Krishna Trithaji, Motilal Banarsidass, New Delhi.

Reference Books:

1. Pride of India- A Glimpse of India's Scientific Heritage edited by Pradeep Kohle et al. Samskrit Bharati (2006).

2. Vedic Physics by Keshav Dev Verma, Motilal Banarsidass Publishers (2012).

3. India's Glorious Scientific Tradition by Suresh Soni, Ocean Books Pvt. Ltd. (2010).

4. Modern Introduction to Ancient Indian Mathematics, T S Bhanumurthy, Wiley Eastern Limited, New Delhi

5. Advance Vedic Mathematics, Rajkumar Thakur, Rupa Publications India Pvt. Ltd 2019

6. Arihant Vedic Mathematics Made Easy - Pt. Ramnandan Shastri

7. Magical World of Mathematics, VG Unkalkar, Vandana publishers, Bangalore

8. Vedic Geometry Course, S. K. Kapoor, Lotus Press

9. Rigvedadi-Bhashya-Bhumika) by Swami Dayanand Saraswati (Author) Translation by Premananda, Swadeshi Store.

10. NPTEL Course: Indian Knowledge System (IKS): Concepts and Applications in Engineering https://onlinecourses.swayam2.ac.in/imb23_mg53/preview

Guidelines for Evaluation:

Activity: A group of 2 students will be assigned a topic related to Indian Knowledge System. Students will explore the topic and will present a poster. The work will be evaluated through presentation of their exploration of the topic.

Oral Examination: The oral examination will be conducted by external examiner on the complete syllabus to evaluate the learning of students on Indian Knowledge Systems.

Kalyani
(Kalyani Kulkarni)

Prof. R.K. Shastri
Subject co-ordinator

Principal
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Engg. / 152 / 2000
PUNE (MS.)

MRA23111-Robot Programming

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	Activity Marks- 20 Marks
		In-sem-30 Marks
		End-sem-60 Marks

Unit -I : Basics Of Robot Programming **(10)**

Robot programming-Introduction-Types- Flex Pendant- Lead through programming, Coordinate systems of Robot, Robot controller- major components, functions-Wrist Mechanism-Interpolation-Interlock commands- Operating mode of robot, JoggingTypes, Robot specifications- Motion commands, end effectors and sensors commands

Unit- II : VAL Language **(9)**

Robot Languages-Classifications, Structures- VAL language commands- motion control, hand control, program control, pick and place applications, palletizing applications using VAL, Robot welding application using VAL program-WAIT, SIGNAL and DELAY command for communications using simple applications

UNIT- III: RAPID Language **(9)**

RAPID language basic commands- Motion Instructions-Pick and place operation using Industrial robot- manual mode, automatic mode, subroutine command based programming. Movemaster command language-Introduction, syntax, simple problems

UNIT -IV: Practical Study of Virtual Robot **(9)**

Robot cycle time analysis-Multiple robot and machine Interference-Process chart Simple problems-Virtual robotics, Robot studio online software-Introduction, Jogging, components, work planning, program modules, input and output signals-Singularities Collision detection-Repeatability measurement of robot-Robot economics.

UNIT -V: Robot Programing Fundamentals **(9)**

VAL-II programming-basic commands, applications- Simple problem using conditional statements-Simple pick and place applications-Production rate calculations using robot. AML Language-General description, elements and functions, Statements, constants and variables-Program control statements- Operating systems, Motion, Sensor commands-Data processing.

UNIT –VI: Robot Programming Applications **(9)**

Robot programming synthesis, robot programming for foundry, press work and heat treatment, welding, machine tools, material handling, warehousing assembly, etc., automatic storage and retrieval system, Robot economics and safety, Robot integration with CAD/CAM/CIM, Collision free motion planning.

References:

1. Deb. S. R. "Robotics Technology and Flexible Automation", Tata McGraw Hill publishing company limited.

2. Mikell. P. Groover, "Industrial Robotics Technology", Programming and Applications, McGraw Hill Co, 1995.
3. Klafter. R.D, Chmielewski.T.A and Noggin's, "Robot Engineering: An Integrated Approach", Prentice Hall of India Pvt. Ltd.,1994.
4. Fu .K. S, Gonzalez .R. C. & Lee .C.S.G, "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill Book co, 1987.
5. Craig .J. J, "Introduction to Robotics Mechanics and Control", Addison- Wesley, 1999.
6. Robotics Lab manual, 2007.

Mrs P. D. Kale
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Head
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MRA23112-Advanced Robot Kinematics and Dynamics

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	Activity Marks-20 Marks
		In-sem-30 Marks
		End-sem-60 Marks

Unit I: Elements of robots – links, joints, actuators, and sensors (7)

Position and orientation of a rigid body, Homogeneous transformations, Representation of joints, link representation using D-H parameters, Examples of D-H parameters and link transforms, different kinds of actuators – stepper, DC servo and brushless motors, model of a DC servo motor, Types of transmissions, Purpose of sensors, internal and external sensors, common sensors – encoders, tachometers, strain gauge based force-torque sensors, proximity and distance measuring sensors, and vision.

Unit II: Kinematics of serial robots (7)

Introduction, Direct and inverse kinematics problems, Examples of kinematics of common serial manipulators, workspace of a serial robot, Inverse kinematics of constrained and redundant robots, Tractrix based approach for fixed and free robots and multi-body systems, simulations and experiments, Solution procedures using theory of elimination, Inverse kinematics solution for the general 6R serial manipulator.

Unit III: Kinematics of parallel robots (7)

Degrees-of- freedom of parallel mechanisms and manipulators, Active and passive joints, Constraint and loop- closure equations, Direct kinematics problem, Mobility of parallel manipulators, Closed-from and numerical solution, Inverse kinematics of parallel manipulators and mechanisms, Direct kinematics of Gough-Stewart platform.

Unit IV: Velocity and static analysis of robot manipulators (7)

Linear and angular velocity of links, Velocity propagation, Manipulator Jacobians for serial and parallel manipulators, Velocity ellipse and ellipsoids, Singularity analysis for serial and parallel manipulators, Loss and gain of degree of freedom, Statics of serial and parallel manipulators, Statics and force transformation matrix of a Gough-Stewart platform, Singularity analysis and statics.

UNIT V: Dynamics of serial and parallel manipulators (7)

Mass and inertia of links, Lagrangian formulation for equations of motion for serial and parallel manipulators, Generation of symbolic equations of motion using a computer, Simulation (direct and inverse) of dynamic equations of motion, Examples of a planar 2R and four-bar mechanism, Recursive dynamics, Commercially available multibody simulation software (ADAMS) and Computer algebra software Maple.

UNIT VI: Motion planning and control (7)

Joint and Cartesian space trajectory planning and generation, Classical control concepts using the example of control of a single link, Independent joint PID control, Control of a multi-link manipulator, Nonlinear model based control schemes, Simulation and experimental case studies on serial and parallel manipulators, Control of constrained manipulators, Cartesian control, Force control and hybrid position/force control, Advanced topics in non-linear control of manipulators.

References:

1. Ghosal,A., Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2nd reprint, 2008.
2. K. S. Fu, R. C. Gonzalez and C. S. G. Lee, "Robotics: Control, Sensing, Vision, and Intelligence," McGraw-Hill Inc., Boston
3. Mark Spong, M. Vidyasagar: Robot Dynamics & Control (Wiley)
4. Hartenberg and Denavit, : Kinematics and Synthesis of Linkages", McGraw Hill Book Co
5. Herman Bruyninckx, : Robot Kinematics and Dynamics,

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MRA23113-Robot Vision System

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	Activity Marks-20 Marks
		In-sem-30 Marks
		End-sem-60 Marks

Unit -I: Vision System: **(8)**

Camera Geometry and Color Sensing, Basic Components - Elements of visual perception: structure of human eye, image formation in the eye – pinhole cameras - colour cameras – image formation model – imaging components and illumination techniques - picture coding – basic relationship between pixels - Camera-Computer interfaces, Image capture and digitization

Unit -II: Low Level Vision Algorithms: **(8)**

Sources of imagery, physics of imaging, Representing, acquiring, and displaying images, Grayscale, color, noise, lens distortion, and filtering. Image representation – image transformation & calibration, gray level transformations, Histogram equalization, image subtraction, image averaging – Filters: smoothing spatial filters, sharpening spatial filters, smoothing frequency domain filters, sharpening frequency domain filters - edge detection, image Convolution,

Unit -III: High Level Vision Algorithms: **(8)**

Image Segmentation (based on discontinuity and similarity), Edge linking and boundary detection, thresholding, Region-oriented segmentation, the use of motion – Description: Boundary Descriptors, Regional Descriptors, Recognition: Decision-Theoretic methods, structural methods. Enhancing features and correcting imperfections, addressing noise, lens distortion, and blurring, Image Morphing, Image Blending, Image Carving, Image transforms; digital Fourier transform, fast Fourier transform, other transforms, correlation; image enhancement; image restoration; Geometric transformation; image compression; error free and lossy compression; edge detection; hough transform, region based segmentation; image feature/region representation and descriptors.

Unit -IV: Object Recognition: **(8)**

Object recognition, Approaches to Object Recognition, Recognition by combination of views – objects with sharp edges, using two views only, using a single view, use of dept values, SVM and Object Recognition

Unit -V: Applications: **(8)**

Camera Calibration - Stereo Imaging - Transforming sensor reading, Mapping Sonar Data, Aligning laser scan measurements - Vision and Tracking: Following the road, Iconic image processing, Multiscale image processing, Video Tracking - Learning landmarks: Landmark spatiograms, K-means Clustering, EM Clustering, Kalman Filtering.

Unit -VI: Robot Vision: **(8)**

Basic introduction to Robotic operating System (ROS) - Real and Simulated Robots - Introduction to OpenCV, Open NI and PCL, installing and testing ROS camera Drivers, ROS to OpenCV – The cv_bridge Package

References:

1. Horn, Berthold K. P. *Robot Vision.* Cambridge, MA: MIT Press /McGraw-Hill, March 1986.

ISBN: 0262081598.
2. Damian m Lyons, "Cluster Computing for Robotics and Computer Vision", World Scientific, Singapore, 2011.
3. Carsten Steger, Markus Ulrich, Christian Wiedemann, "Machine Vision Algorithms and Applications", WILEY- VCH, Weinheim, 2008.
4. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", Addition – Wesley Publishing Company, New Delhi, 2007.
5. Shimon Ullman, "High-Level Vision: Object recognition and Visual Cognition", A Bradford Book, USA, 2000.
6. R.Patrick Goebel, " ROS by Example: A Do-It-Yourself Guide to Robot Operating System – Volume I", A Pi Robot Production, 2012.
7. Bernd Jahne, "Digital Image Processing", Springer Publication, 2013.

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For M.S.Kale
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VPKBIET

Program Elective-1

MRA23114-A-Mechatronics Systems and Applications

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures:4 hrs/week	TH:4	Activity Marks = 20
		In-sem-30 Marks
		End-sem-60 Marks

Unit -I: Introduction to Mechatronics **(8)**

Introduction to Mechatronics - Systems - Mechatronics in Products – Measurement Systems – Control Systems - Traditional design and Mechatronics Design.

Unit –II: Sensors and Transducers **(8)**

Introduction - Performance Terminology - Displacement, Position and Proximity -Velocity and Motion –Fluid pressure - Temperature sensors - Light sensors - Selection of sensors - Signal processing – Servo systems.

Unit –III: Microcontrollers **(8)**

Introduction - Architecture - Pin configuration - Instruction set - Programming of Microprocessors using 8085 instructions - Interfacing input and output devices - Interfacing D/A converters and A/D converters –Applications - Temperature control - Stepper motor control - Traffic light controller.

Unit –IV: Input output Systems **(8)**

Interfacing requirements, interface adapters, buffers, Tri-state buffers, hand shaking and Serial interfacing. Parallel interfacing, Function of synchronous communication, Networks.

Unit –V: Programmable Logical Controllers **(8)**

Basic structure of PLC, program of PLC, logic functions, latching and sequencing, Develop programs involving timers, internal relays, counters, shift registers, PLC Programming.

Unit –VI: Mechatronics Systems & Applications **(8)**

Case studies of Mechatronic systems designs, like piece counting system, Pick and place manipulator, Simple assembly task involving a few parts, Part loading / unloading system, Automatic tool and pallet changers etc. Fault finding and troubleshooting.

References:

1. Bolton, "Mechatronics: Electronic Control System in Mechanical and Electrical Engineering", Pearson Education Ltd. ISBN:8131732533
2. B. H. Histard, D. G. Alciator, "Introduction to Mechatronics and Measurement Systems", Tata McGraw Hill Publication, ISBN 0-07-052970-8.
3. B. C. Kuo, "Automatic Control Systems", prentice Hall, ISBN 0-87-692480-1.
4. Programmable Logical Controller", Hackworth, Pearson Education, (2008)
5. C. D. Johnson, "Process Control Instrumentation Technology", Prentice Hall of India Pvt. Ltd., New Delhi.
6. D. Shetty, R. Kolk, "Mechatronics System Design", Thomson Books Pub., ISBN98-1240062-2.
7. AppuKuttam "Mechatronics", Oxford Publications, 1st Edition.
8. Gary Dunning, "Programmable Logical Controller", Cengage Learning, 3rd Edition.

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For m.s.[illegible]

Head

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VPKBIET Baramati-413133

Program Elective1

MRA23114-B-Flexible Manufacturing Systems

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures:4 hrs/week	TH:4	Activity Marks = 20
		In-sem-30 Marks
		End-sem-60 Marks

Unit -I: Introduction **(8)**

Introduction to manufacturing system, different type of manufacturing system, volume variety relationship for understanding manufacturing system.

Flexible Manufacturing System: Components of an FMS, types of system, where to apply FMS technology, FMS work stations. Material handling and storage system: Functions of the handling system, FMS layout configuration, Material handling equipment.

Unit- II : Distributed data processing in FMS **(8)**

DBMS and their applications in CAD/CAM and FMS distributed systems in FMS –Integration of CAD and CAM - Part programming in FMS, tool data base - Clamping devices and fixtures data base.

Unit- III: Group Technology **(8)**

Cellular Manufacturing-Part families, part classification and coding. Types of classification and coding system, Machine cell design: The composite part concept, types of cell design. Virtual Cell Manufacturing System.

Just In Time and Lean Production: Lean Production and Waste in manufacturing, just in time production system, automation, work involvement.

Unit -IV: Production Planning and control systems **(8)**

Aggregate Production Planning and the master production schedule, Material Requirements and Planning, capacity planning, shop floor control, inventory control, extensions of MRP

Computer Aided Process Planning: Generative and variant types, backward and forward approach, feature based and CAD based CAPP.

UNIT-V : FMS-Support Systems **(8)**

Contact and non-contact inspection principles - programming and operation-in cycle gauging. Part programming in FMS, tool data base - Clamping devices and fixtures data base. Material Handling systemsin FMS: Conveyors

- AGVs – industrial robots in material handling - AS/RS.

UNIT-VI: Computer control system **(8)**

Computer function, FMS data file, system reports planning the FMS, analysis method for FMS, application and benefits. Interfacing of computers, machine tool controllers and handling systems: communications standards Programmable Logic Controllers (PLC's) – Interfacing, Computer aided Project planning- dynamic part scheduling.

References:

1. Paul Ranky., "The design and operation of FMS", IFS publication
2. Mikell P Groover, "Automation Production systems, Computer Integrated Manufacturing", Prentice Hall

3. David J. Parrish, "Flexible Manufacturing" Butterworth-Heinemann, 1990
4. Computer Aided Manufacture by Chien Chang and Richard A Wysk, Prentice HALL
5. P. Radhakrishnan, S. Subramanyan, "CAD / CAM / CIM", New Age International.
6. William W Luggen, "Flexible Manufacturing Cells and System" Prentice Hall of Inc New Jersey, 1991
7. Reza A Maleki "Flexible Manufacturing system" Prentice Hall of Inc New Jersey, 1991

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Program Elective-1

MRA23114-C-Instrumentation & Sensors

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures:4 hrs/week	TH:4	Activity Marks = 20
		In-sem-30 Marks
		End-sem-60 Marks

Unit -I : Sensor Based Measurement Systems **(8)**

General Concepts And Terminology, Sensor Classification, General Input-Output Configuration, Static Characteristics Of Measurement Systems, Dynamic Characteristics, Other Sensor Characteristics, Primary Sensors, Materials For Sensors, Microsensors Technology.

Unit- II : Displacement, Force, Pressure Sensors. **(8)**

Measurement of displacement using Potentiometer, LVDT & Optical Encoder, Measurement of force using strain gauge, Measurement of pressure using LVDT based diaphragm & piezoelectric sensor.

Unit- III: Temperature, Position, Proximity, Flow and Level Sensors.

(8

) Measurement of temperature using Thermistor, Thermocouple & RTD, Concept of thermal imaging, Measurement of position using Hall effect sensors, Proximity sensors: Inductive & Capacitive, Use of proximity sensor as accelerometer and vibration sensor, Flow Sensors: Ultrasonic & Laser, Level Sensors: Ultrasonic & Capacitive.

Unit -IV: DAQ Methods **(8)**

Data Acquisition Methods: Basic block diagram, Analog and Digital IO, Counters, Timers, Types of ADC: successive approximation and sigma-delta, Types of DAC: Weighted Resistor and R-2R Ladder type, Use of Data Sockets for Networked Communication.

Unit -V: Intelligent Sensors **(8)**

Intelligent Sensors: General Structure of smart sensors & its components, Characteristic of smart sensors: Self calibration, Self-testing & self-communicating, Application of smart sensors: Automatic robot control & automobile engine control.

Unit -VI: Virtual Instrumentation **(8)**

Virtual Instrumentation: Graphical programming techniques, Data types, Advantage of Virtual Instrumentation techniques, Concept of WHILE & FOR loops, Arrays, Clusters & graphs, Structures: Case, Sequence & Formula nodes, Need of software based instruments for industrial automation.

References:

1. D. Patranabis, "Principle of Industrial Instrumentation", Tata McGraw Hill
2. DVS Murthy, Transducers and Instrumentation, PHI 2nd Edition 2013
3. S. Gupta, J.P. Gupta / PC interfacing for Data Acquisition & Process Control, 2nd ED / Instrument Society of America, 1994.
4. Gary Johnson / Lab VIEW Graphical Programing II Edition / McGraw Hill 1997
5. Bolton, "Mechatronics: Electronic Control System in Mechanical and Electrical Engineering", Pearson Education Ltd. ISBN:8131732533

6 D. Shetty, R. Kolk, "Mechatronics System Design", Thomson Books Pub., ISBN98-1240062-2.

10. E.O. Doebelin, "Measurement Systems", McGraw Hill.
11. Arun K. Ghosh, Introduction to measurements and Instrumentation, PHI, 4th Edition 2012
12. A.D. Helfrick and W.D. Cooper, Modern Electronic Instrumentation & Measurement Techniques, PHI – 2001

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Program Elective-I

MRA23114-D-CAD/CAM

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures:4 hrs/week	TH:4	Activity Marks = 20
		In-sem-30 Marks
		End-sem-60 Marks

UNIT- I: Introduction

(8)

Brief introduction – definition, Types of Manufacturing, evolution of CIM, CIM hardware and CIM software, Nature and role of the elements of CIM System, Development of CIM, **Product development through CIM** – product development cycle, Sequential Engineering vs Concurrent engineering, implementation of concurrent engineering, CE and Information technology, soft and hard prototyping, Characteristics of CE, key factors influencing the success of CE.

UNIT- II: Production Planning and Control and Computerised Process Planning **(8)**

Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control-Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP) - Simple Problems

UNIT –III: Automation and Intelligent Machines **(8)**

Basic Group Technology layouts, process layouts, product layouts, Comparison of process and product layouts, designing process layouts – block diagramming, relationship diagramming, service layouts, designing product layouts – Line balancing, Coding System - Simple Problems in Opitz Part Coding system. Machines for flexible automation, Controllers, Sensors, Intelligent machines.Customer/Supplier communication – network and distribution.

UNIT –IV: Flexible Manufacturing System **(8)**

Flexible manufacturing Systems vs dedicated manufacturing systems, cellular manufacturing systems, major elements of FMS, FMS Application & Benefits – FMS Planning and Control– Quantitative analysis in FMS – Simple Problems, problems with FMS. Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance technology – Vehicle Management & Safety.

UNIT- V: Distributed Numerical Control **(8)**

DNC system – communication between DNC computer and machine control Unit – hierarchical processing of data in DNC system – features of DNC system. Adaptive control in Machine control Unit. Networking concepts, LOSI, MAP, TOP, LAN, WAN, Communication interface, bus architecture, topologies, and protocols .Manufacturing data base.

UNIT –VI: Robots in Computer Integrated Manufacturing **(8)**

Robot Anatomy and Related Attributes – Classification of Robots- Performance capabilities, programming robots, geometric requirements to the CAD/Robot linkage, Simulation, Adaptive control, Robot operation, End of Arm tooling, control system operation, Application of industrial robot, integration of industrial robot into a CIM system. **References:**

1. A. Alavudeen, N.Venkateshwaran, "Computer Integrated Manufacturing", PHI Learning Private Ltd. ISBN: 978-81-203-3345-1
2. P. Radhakrishnan, S.Subramanyan, V.Raju, "CAD/CAM/CIM", New Age

International Ltd. ISBN: 81- 224-1248-3
3. Mikell.P.Groover "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India, 2008.August-Wilhelm Scheer, "CIM. Computer Integrated Manufacturing: Towards the Factory of the Future", Springer
4. Alan Weatherhall," Computer Integrated Manufacturing: From Fundamental to implementation", Butterworth & Co. Ltd, ISBN: 0-408-00733-8
5. Kant Vajpayee S, "Principles of Computer Integrated Manufacturing", Prentice Hall India, 2003.
6. Gideon Halevi and Roland Weill, "Principles of Process Planning – A Logical Approach" Chapman & Hall, London, 1995.

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For M.S.Kande

Head

Department of Mechanical Engineering

VPKBIET Baramati-413133

MRA23115-Laboratory Proficiency II

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 8hrs/week	PR:4	TW-50 Marks
		OR-50 Marks

1. Study components of an industrial robot (Kuka, Mitsubishi, Fanuc, ABB etc.) and its DH parameters.
2. Forward kinematics and validation using a software (Robo Analyser/ MatLab or any other free software tool).
3. Inverse kinematics of an industrial robot and validation using any open source software.
4. Industrial Robot programming using RAPID, MELFA, VAL II or equivalent.
5. Use of open source computer vision programming tool/ MatLab, open CV.
6. Research related experiment in AI, e.g. multi agent system, unmanned systems control using ROS, etc.
7. Small group project work relevant to Industrial automation.

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Head
Department of Mechanical Engineering
VPKBIET Baramati-413133

MSE23116-Environmental Studies

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 2 hrs./week	TH:2	Activity Marks = 30
		Oral -30 Marks

Unit 1 : Multidisciplinary nature of environmental studies: 4Hrs

Definition, scope and importance, Need for public awareness.

Unit 2 : Natural Resources : 4Hrs

Renewable and non-renewable resources, Role of an individual in conservation of natural resources, Equitable use of resoureces for sustainable lifestyles.

Unit 3 : Ecosystems 4Hrs

Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, characteristic features, structure and function of the various ecosystem.

Unit 4 : Biodiversity and its conservation 4Hrs

Introduction – Definition : genetic, species and ecosystem diversity, Biogeographical classification of India, Value of biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, National and local levels, India as a mega-diversity nation

Unit 5 : Environmental Pollution 4Hrs

Definition, Cause, effects and control measures of a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear hazards, Solid waste Management, Pollution case studies.

Unit 6 : Social Issues and the Environment 4Hrs

Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Environmental ethics : Issues and possible solutions, Environment Protection Act. , Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act.

Mr. U. T. Jagadale
PG Coordinator

Dr. C. B. Nayak
Head, Civil Engg. Dept.

MRA23201-Artificial Intelligence in Robotics

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	Activity Marks: 20 Marks
		In-sem-30 Marks
		End-sem-60 Marks

Unit -I: Scope of AI and Problem solving **(8)**

Introduction to Artificial Intelligence-Introduction, Intelligent agents, Problem solving by search, Adversarial search.

Unit- II: Planning: **(8)**

The planning problem, planning with state-space search, partial-order planning, planning graph, planning with propositional logics. Planning & acting in the real world.

Unit -III: Knowledge Representation & Learning **(8)**

Uncertainty, probabilistic reasoning-Bayesian Network, probabilistic reasoning over time-Inference in temporal Model, Hidden Markov models-Kalman filters, Dynamic Bayesian Network, speech recognition.

Learning: Concept of learning, learning automation, genetic algorithm, learning by inductions, neural nets. Programming Language: Introduction to programming Language. Handling Uncertainties: Non-monotonic reasoning, Probabilistic reasoning, use of certainty factors, Fuzzy logic

Unit -IV: Expert system **(8)**

Expert system – Introduction, difference between expert system and conventional programs, basic activities of expert system – Interpretation, Prediction, Diagnosis, Design, Planning, Monitoring, Debugging, Repair, Instruction, Control. Basic aspects of expert system –Acquisition Unit, Knowledge base – Production rules, semantic net, frames. Inference engine – Backward chaining and forward chaining. Explanatory interface.

Unit -V: Communication & Perception **(8)**

Communication, Probabilistic language processing-probabilistic-language models-information retrieval- extraction-machine translation, perception-image formation- image processing operations-object recognition

Unit -VI: AI in Robotics: **(8)**

Robotic perception, localization, mapping- configuring space, planning uncertain movements, dynamics and control of movement, Ethics and risks of artificial intelligence in robotics. Case study of AI in robotics.

References:

1. Stuart Russell, Peter Norvig, Artificial Intelligence: A modern approach, Pearson Education, India.
2. Negnevitsky, M, Artificial Intelligence: A guide to Intelligent Systems,. Harlow: Addison-Wesley, 2002.

3. E. Rich and K. Knight, "Artificial intelligence", TMH, 2nd ed..
4. Nilsson, N. J. (1986). Principles of artificial intelligence. Morgan Kaufmann.
5. Craig, J. J. (2009). Introduction to robotics: mechanics and control, 3/E. Pearson Education India.
6. D.W. Patterson, "Introduction to AI and Expert Systems", PHI, 1992.
7. Peter Jackson, "Introduction to Expert Systems", AWP, M.A., 1992.
8. R.J. Schalkoff, "Artificial Intelligence - an Engineering Approach", McGraw Hill Int. Ed., Singapore, 1992.
9. M. Sasikumar, S. Ramani, "Rule Based Expert Systems", Narosa Publishing House, 1994.

Mrs P. D. Kale
PG coordinator

for

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VPKBIET Baramati-413133

MRA23202-Soft Computing in Robotics

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	Activity Marks: 20 Marks
		In-sem-30 Marks
		End-sem-60 Marks

Unit -I: Evolutionary algorithms **(8)**

Evolutions strategies and evolutionary programming, Genetic algorithms, introduction to classifier systems, genetic programming,

Unit-II: Algorithms based on Swarm Intelligence **(8)**

Particle swarm optimization, ant colony optimization, artificial bee colony optimization, shuffled frog leaping algorithm, firefly algorithm, grey wolf optimization, back widow optimization. Portfolio optimization

Unit -III: Artificial Neural Networks **(8)**

Artificial neurons, Networks of Artificial Neurons, Neural Learning, Supervised Learning, Unsupervised Learning, Fault Tolerance, Artificial Neural Nets and Statistics, ANN data selection, Evolutionary Design of Artificial Neural Networks: Evolving weights, network architecture, learning rules etc.

Unit -IV: Fuzzy systems **(8)**

Fuzzy sets, fuzzy relations, the extension principle, fuzzy arithmetic, fuzzy logic, possibility theory, applications of fuzzy systems. Evolutionary Design of Fuzzy rule based Systems: Evolving fuzzy decision rules, fuzzy queries, fuzzy filters.

Unit -V: Neuro-fuzzy Systems **(8)**

Fuzzy Neural Networks, Cooperative Neuro-fuzzy Systems, Applications of Neuro-fuzzy Systems, Fuzzy Control of Evolution, Fuzzy Evolutionary Algorithms, Natural Parallel Soft Computing

Unit -VI: Applications of Soft computing in robotics **(8)**

Soft computing in robotics applications such as: Robot path planning, Trajectory generation, inverse kinematics and dynamics, Robotic controller design, robot clustering, robot sorting, robot collaboration, Obstacle avoidance etc.

Books:

1. Samir Roy, Udit Chakraborty, 'Soft Computing', Pearson Education India, 2013, ISBN: 9789332514201
2. D. K. Pratihar, 'Soft Computing' Alpha Science International, 2008, ISBN: 9781842654378
3. S.N.Sivanandam, S.N.Deepa, 'Principles of Soft Computing', John Wiley & Sons, 2007, ISBN: 9788126510757
4. Pawar P. J., 'Evolutionary Computations for Manufacturing', Studium Press, 2019, ISBN: 9789385046520

Mrs. P. P. Kale
PG Coordinator

For Head
Department of Mechanical Engineering
VPKBIET Baramati-413133

Program Elective-II
MRA23203-A-Programming and Data Structure

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	Activity Marks: 20 Marks
		In-sem-30 Marks
		End-sem-60 Marks

Unit -I: C Programming Fundamentals **(8)**
Introduction to the basic ideas of problem solving and programming using principles of top-down modular design, Flowcharts, Compilation of a Program with examples Conditional statements.

Unit -II: C Programming Advanced Features **(8)**
Data Types, Instruction and its Types, Storage Classes, Operators and Hierarchy of Operations, Expressions in C, Control and Repetitive Statements, break, continue, Arrays, Strings.

Unit- III: Introduction to Data Structure **(8)**
Basic terminologies; introduction to basic data Structures: Arrays, linked list, trees, stack, queue, Graph; Data structure operations; Algorithm complexity: definition, types and notations.

Unit -IV: Linear Data Structures **(8)**
Abstract Data Types (ADTs) – List ADT – array-based implementation – linked list implementation — singly linked lists- circularly linked lists- doubly-linked lists – applications of lists –Polynomial Manipulation – All operation (Insertion, Deletion, Merge, Traversal)

Unit -V: Linear Data structures **(8)**
Stack ADT – Evaluating arithmetic expressions- other applications- Queue ADT – circular queue implementation – Double ended Queues – applications of queues

Unit- VI: Sorting, Searching and Hash Techniques **(8)**
Sorting algorithms: Insertion sort – Selection sort – Shell sort – Bubble sort – Quick sort – Merge sort – Radix sort – Searching: Linear search –Binary Search Hashing: Hash Functions – Separate Chaining – Open Addressing – Rehashing Extendible Hashing

References:

1. Robert Kruise, C L Tondo and Bruce Leung, "Data Structures"
2. Brian W. Kernighan and Dennis M. Ritchie, "The C Programming Language", 2nd Edition, Pearson Education, 1988.
3. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", 2nd Edition, Pearson Education, 1997.
4. "Schaum's Outline of Programming with C" by Byron Gottfried
5. Data structures: A Pseudocode Approach with C, 2nd edition,
6. R.F.Gilberg and B.A. Forouzan, "data Structures" Cengage Learning.
7. M.A.Weiss, Data structures and Algorithm Analysis in C, 2nd edition, Pearson.
8. A.M.Tanenbaum,Y. Langsam, M.J.Augenstein, Data Structures using C, Pearson.
9. R.Kruse, C.L.Tondo and B.Leung, Data structures and Program Design in C, 2nd edition, Pearson
10. R G Dromey, "How to Solve it by Computer" , Pearson Education

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VPKBIET Baramati-413133

Program Elective-II

MRA23203-B- MEMS and Microsystems

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	Activity Marks: 20 Marks
		In-sem-30 Marks
		End-sem-60 Marks

Unit -I: Over view of MEMS and Microsystems **(8)**

Definition, historical development, properties, design and fabrication micro-system, microelectronics, working principle, applications and advantages of micro system. Substrates and wafers, silicon as substrate material, mechanical properties of Si, Silicon Compounds, silicon piezo resistors, Galium arsenide, quartz, polymers for MEMS, conductive polymers.

Unit- II : Fabrication Processes **(8)**

:Photolithography, photo resist applications, light sources, ion implantation, diffusion Oxidation thermal oxidation, silicon dioxide, chemical vapour deposition, sputtering, deposition by epitaxy, etching, bulk and surface machining, LIGA process – LASER, Electron beam,Ion beam processes Mask less lithography

Unit -III: Micro Devices **(8)**

Sensors – classification – signal conversion ideal characterization of sensors micro actuators, mechanical sensors – measurands - displacement sensors, pressure sensor, flow sensors, Accelerometer , chemical and bio sensor - sensitivity, reliability and response of micro-sensor - micro actuators – applications.

Unit- IV: MEMS Accelerometers **(8)**

MEMS Accelerometers for Avionics, Piezoresistive Accelerometer Technology, MEMS Capacitive Accelerometer, MEMS Capacitive Accelerometer Process

UNIT-V: Microsystem Packaging **(8)**

Micro system packaging, packaging design levels of micro system packaging -Levels of packaging, interfaces in packaging – packaging technologies, Assembly of Microsystems Packaging materials, Comparison between IC and MEMS packaging, Packaging technologies: Die preparation, surface bonding, wire bonding, sealing, Pressure sensor packaging

UNIT-VI:Bio-MEMS **(8)**

Introduction to Bio MEMS, Cell Electrophysiology, Silicon Micro-fabrication, Microfluidics and Bio-MEMS applications, MEMS for Drug delivery.

References:

1. Chang Liu, Foundations of MEMS, Prentice Hall (Pearson)
2. Tai – Ran Hsu, MEMS and Microsystems Design and Manufacture, Tata-McGraw Hill, New Delhi
3. Julian W. Gardner & Vijay K. Varadan, "Micro-sensors, MEMS and smart Devices", John Wiley & Sons,.
4. Julian W. Hardner Micro Sensors, Principles and Applications, CRC Press 1993.
5. Mark Madou , Fundamentals of Microfabrication, CRC Press, New York, 1997.
6. Mohamed Gad-el-Hak, MEMS Handbook, CRC press, 2006, ISBN : 8493-9138-5
7. Norio Taniguchi, Nano Technology, Oxford University Press, New York, 2003

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Department of Mechanical Engineering

VPKBIET Baramati-413133

Program Elective-II

MRA23203-C- Mobile and Autonomous Robots

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	Activity Marks: 20 Marks
		In-sem-30 Marks
		End-sem-60 Marks

Unit I: Introduction to Mobile Robots **(8)**

Tasks of mobile robots, robot manufacturers, type of obstacles and challenges, tele-robotics, philosophy of robotics, service robotics, types of environment representation. Ground Robots: Wheeled and Legged Robots, Aerial Robots, Underwater Robots and Surface Robots.

Unit II: Robot locomotion **(8)**

Types of locomotion, hopping robots, legged robots, wheeled robots, stability, maneuverability, controllability **Mobile robot kinematics and dynamics:** Forward and inverse kinematics, holonomic and nonholonomic constraints, kinematic models of simple car and legged robots, dynamics simulation of mobile robots

Unit III: Sensors for localization **(8)**

Magnetic and optic position sensor, gyroscope, accelerometer, magnetic compass, inclinometer, GNSS and Sensors for navigation: tactile and proximity sensors, ultrasound rangefinder, laser scanner, infrared rangefinder, visual system .Current application and limitations of Mobile Robots.

Unit IV: Autonomous Robots **(8)**

The Basics of Autonomy (Motion, Vision and PID), Programming Complex Behaviors (reactive, deliberative, FSM), Robot Navigation (path planning), Robot Navigation (localization), Robot Navigation (mapping), Humanoid Robots and the DARPA challenge, Swarm Robotics, Telecheric robots, Robot Applications and Ethics.

Unit-V: Broad area Applications **(8)**

Automatic guidance, sowing, weeding, spraying and broad-acre harvesting, Horticulture: picking of fruits- Robot milking, sheep shearing, slaughtering, livestock inspection- Robots in construction, unsolved problems in construction, Future directions- Robots for hazardous applications, enabling technologies- Search and Rescue robotics: Disaster Characteristics- Impact on Robots

Unit-VI: Medical robotics, Core concepts, Technology **(8)**

Medical robotic systems, Research areas and applications- Rehabilitation and Health care robotics: Overview, physical therapy and training Robots- Aids for people with disabilities- Smart prostheses and orthoses, diagnosis and monitoring.

Cleaning Robots, lawn moving Robots- Smart appliances and smart homes- The role of Robots in education, Educational robotic platforms-. Robots and informal learning venues

References:

1. Bruno Siciliano, Oussama Khatib, —Springer Handbook of Robotics‖, Springer-Verlag
2. Yangsheng Xu, Huihuan Qian, Xinyu Wu, "Household and Service Robots", Elsevier Ltd, 2015.
3. R. Siegwart, I. R. Nourbakhsh, “Introduction to Autonomous Mobile Robots”, The MIT Press, 2011.

4. Aleksandar Lazinica, —Mobile Robots towards New Applications, Advanced Robotic Systems International, 2006.
5. Gregory Dudek, Michael Jenkin, —Computational Principles of Mobile Roboticsl, 2nd edition, Oxford University Press, 2010.
6. L Marques, A. de Almeida, Mo.Tokhi,G.S. Virk, —Advances in Mobile Robotics, World Scientific Publishing Co. Pte. Ltd. 2008.

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For MSLanb

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Department of Mechanical Engineering

VPKBIET Baramati-413133

Program Elective-II
MRA23203-D-Simulation and Modeling

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	Activity Marks: 20 Marks
		In-sem-30 Marks
		End-sem-60 Marks

Unit -I: Introduction modelling strategy **(8)**

System, environment, input and output variables, State variables; Static and Dynamic systems; Hierarchy of knowledge about a system and Modeling Strategy.

Introduction of Physical Modeling: Dimensions analysis, Dimensionless grouping of input and output variables of find empirical relations, similarity criteria and their application to physical models

Unit -II : Modelling of System with Known Structure **(8)**
Review of conservation laws and the governing equation for heat, mass and momentum transfer, Deterministic model-(a) distributed parameter models in terms of partial identification and their solutions and (b) lumped parameter models in terms of differential and difference equations, state space model, transfer functions block diagram and sub systems, stability of transfer functions, modelling for control

Unit -III: Optimizations and Design of Systems **(8)**
: Summary of gradient based techniques: Nontraditional Optimizations techniques genetic Algorithm (GA)- coding, GA operations elitism, Application using MATLAB: Simulated Annealing.

Unit- IV: Neural Network Modeling of Systems only with Input-output Database: **(8)**

Neurons, architecture of neural networks, knowledge representation, learning algorithm. Multilayer feed forward network and its back propagation learning algorithm, Application to complex engineering systems and strategy for optimum output

UNIT-V: Modeling Based on Expert Knowledge: **(8)**
Fuzzy sets, Membership functions, Fuzzy Inference systems, Expert Knowledge and Fuzzy Models, Design of Fuzzy Controllers

UNIT-VI : Simulation of Engineering Systems: **(8)**
Monte-Carlo simulation, Inventory Control Simulation using Monte Carlo Technique, Simulation of continuous and discrete processes with suitable examples from engineering problems

References:

1. Zeigler B.P. Praehofer. H. and Kim I.G. "Theory of modeling and simulation", 2 nd Edition. Academic press, 2000
2. Ogata K , "Modern control Engineering" 3 rd edition. Prentice hall of India 2001
3. Jang J.S.R. sun C.T and Mizutani E,, "Neuro-Fuzzy and soft Computing ", 3 rd

edition, Prentice hall of India, 2002
4. Shannon, R. E., "System Simulation: the Art and Science", Prentice Hall Inc. 1990
5. Pratab. R " Getting started with MATLAB" Oxford university Press 2009
6. Averill M Law and W D Kelton, "Simulation Modelling and analysis", 3rd edition McGraw- Hill

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For M. Sharma

Head

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VPKBIET Baramati-413133

MRA23204-Dissertation Stage I

Teaching Scheme	Credit scheme	Examination Scheme
Practical: 8 hrs/week	PR:4	TW-100 Marks
		OR-50 Marks

Dissertation Stage–I is an integral part of the Dissertation work. In this, the student shall complete the partial work of the Dissertation which will consist of problem statement, literature review, design, scheme of implementation (Mathematical Model/ SRS/ UML/ ERD /block diagram/ PERT chart,) and Layout & Design of the Set-up. The student is expected to complete the dissertation at least up to the design phase. As a part of the progress report of Dissertation work Stage-I, the candidate shall deliver a presentation on the advancement in Technology pertaining to the selected dissertation topic. The student shall submit the duly approved and certified progress report of Dissertation Stage-I in standard format for satisfactory completion of the work by the concerned guide and head of the Department/ Institute. The examiner will be assessed by a panel of examiners of which one is necessarily an external examiner. The assessment will be broadly based on literature study, work undergone, content delivery, presentation skills, documentation, and report. The students are expected to validate their study undertaken by publishing it at standard platforms. The investigations and findings need to be validated appropriately at standard platforms – conference and/or peer reviewed journal. The student must exhibit the continuous progress through regular reporting and presentations and proper documentation of the frequency of the activities at the sole discretion of the PG coordination. The continuous assessment of the progress needs to be documented unambiguously. For standardization and documentation, it is recommended to follow the formats and guidelines circulated / as in the dissertation workbook approved by the Board of Studies.

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For M.S.Kerty

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Department of Mechanical Engineering

VPKBIET Baramati-413133

MHS23201- Constitution of India

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 2 hrs/week	TH:2	Activity Marks = 10 Marks
		Oral-25 Marks

Course Objectives:

- To realise the significance of constitution of India to students from all walks of life and help them to understand the basic concepts of Indian constitution.
- To identify the importance of fundamental rights as well as fundamental duties.
- To understand the functioning of Union, State and Local Governments in Indian federal system.
- To learn procedure and effects of emergency, composition and activities of election commission and amendment procedure.

Course Outcomes: At the end of the course the student should be able to:

CO1. Understand and explain the significance of Indian Constitution as the fundamental law of the land.

CO2. Utilize his fundamental rights in proper sense at the same time identifies his responsibilities in national building.

CO3. Analyse the Indian political system, the powers and functions of the Union, State and Local Governments in detail

CO4. Understand Electoral Process, Emergency provisions and Amendment procedure

UNIT-I Introduction to Constitution: **6 hours.**

Meaning and importance of the Constitution, salient features of Indian Constitution. Preamble of the Constitution. Fundamental rights. Directive principles of state policy and Fundamental duties

UNIT-II Union Government: **6 Hours.**

Union Executive, Union Legislature and Union Judiciary-Supreme Court of India – composition and powers and functions.

UNIT-III State and Local Governments: **6 hours**

State Executive- Governor, Chief Minister, Council of Ministers. State Legislature-State Legislative Assembly and State Legislative Council. State Judiciary-High court. Local Government-Panchayat raj system with special reference to 73rd and Urban Local Self Govt. with special reference to74th Amendment.

UNIT-IV Election provisions **6 hours.**

Election Commission of India-composition, powers, functions and electoral process. Types of emergency-grounds, procedure, duration and effects. Amendment of the constitution- meaning, procedure and limitations.

Textbooks

1. M.V.Pylee, "Introduction to the Constitution of India",4th Edition, Vikas publication, 2005.

2. Durga Das Basu(DD Basu) , "Introduction to the constitution of India",(Student Edition),19th edition,Prentice-Hall EEE, 2008.

Reference Book

1. Merunandan, "Multiple Choice Questions on Constitution of India", 2 nd Edition,Meraga publication,2007.

ASP. Anil Patil

M. S. Lande

MRA23205- Industrial Management

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 2 hrs/week	TH:2	Activity Marks = 10 Marks
		Oral=25 Marks

Course Objectives:

- Engineering disciplines are expected to work during most of their career at middle level. They are also expected to deal with workforce and management problems.
- In the present era of competition, optimum utilization of the resources with achieving higher productivity is essential for any industry to survive. Quality and cost controls are also other important factors which contribute to the day to day supervision issues.

Course Outcome-On completion of the course students will be able

Co1-To interpret and acquire major management skills, familiarize with different leadership styles

CO2-To acquire the knowledge of different types of plant layout, Production modes and PPC functions

CO3-To understand the need of Total Quality management and appreciate the usage of TQM tools in quality control

CO4-To acquire the knowledge of different types of Plant maintenance and measures and procedure observed in industry towards safety

Course Contents

Unit I: Basics of Management **06hrs**

Management - Definition – Administration- Definition – Henry-Fayol's principles of management- Business Organization-Types- Proprietorship-Partnership- Joint stock-Cooperative Society-Advantages and disadvantages -Functions of Management –

Organization-Definition- types of organization –Line-Functional-Line &staff-advantages and disadvantages- Leadership -Types –Quality of good leader

Motivation - Maslow's Theory of Motivation -Hierarchy of needs- Communication - Process of Communication – Barriers for effective communication.

Unit II: Production Management **06hrs**

Concept of project work - Project planning -Market survey- Project capacity-selection of site for project Plant layout-Types of Plant layout

Product design-Stages in product design drawing-Specifications-Material requirement-operation-Planning-Production-definition-Job, Batch & Mass production with their advantages and disadvantages-

Productivity-definition factors to improve productivity- Production planning and Control (PPC)-definition-Functions of PPC- planning, routing, scheduling, dispatching and Inspection-

Unit III: Total quality management **06 Hrs**

Quality–Concept-Quality control- Definition - Factors affecting quality- Advantages of quality control –Inspection-Different types of inspection

Total Quality Management-Meaning- Principles of total quality management-PDCA cycles Quality Circles-definition-Function.

TQM Tools- Flow charts, Control charts, Histograms, Pareto charts, Cause and effect diagram-5-S- Kaizen, and Six-sigma

Quality Certification Systems- ISO 9000 series quality standards

Unit IV: Plant maintenance and industrial safety **06 Hrs**

Plant maintenance-Definition -Types of maintenance-Preventive maintenance- Break down maintenance-Advantages and disadvantages-

Total Productive Maintenance-Meaning benefits of TPM -Tools of TPM- planned maintenance and predictive maintenance.

Industrial safety –Meaning - Accident- causes for accident- Direct and indirect losses due to an accident-Personal protective devices for preventions of accidents-

Safety department- role of safety officer – safety supervisor -safety committee – Fire prevention and Protection- Fire triangle-principles of fire extinguishing- various classes of fire- A, B,C, D types of fire extinguishers

Text books and references

1. Industrial Organization and Engineering Economics T.R.Banga & S C Sharma Khanna.Publishers
2. Industrial management and organizational behavior K.K.Ahuja
3. Industrial management and engineering economics O.P.khanna Khanna publishers
4. Production and operations management -Dr .K.Aswathappa and Dr.Sreedhar Bhatt Himalaya publishers
5. Safety Management in Industry Krishnan.N V Jaico Publishing House, Bombay, 1997
6. Total Quality Management S Raja Ram, Shivashankar

Mrs. P.D.Kale
PG Coordinator

for

Department of Mechanical Engineering
VPKBIET Baramati-413133

MRA23211- Seminar

Teaching Scheme	Credit Scheme	Examination Scheme
Practical : 4 hrs/week	PR: 2	TW-50 Marks
		OR-50 Marks

Conduction guidelines:

1. This is a 2-credit course aimed at teaching 2nd year MTech students to make research presentations.
2. Each student has to choose a paper / topic related to Robotics and Automation. It need not be related to the M. Tech project. Some suggestions are
    a. A detailed literature review of a specific research problem. This can include: background related to the problem, categorization of approaches, specific approaches, etc.
    b. One selected journal/TOP-tier conference paper published by others.
3. Each student is allotted exactly **15 minutes** for presentation; and **5 minutes** for Q&A. Marks will be given based on content, organization, clarity of delivery and ability to answer questions.
4. A report must be submitted based on the content of the seminar duly signed by the guide and Head of Department.

Kale

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For M.S.Ekatpure

Department of Mechanical Engineering
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MRA23212-Industry Internship/ In-house Research Project

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 20 hrs/week	PR:10	TW-150 Marks
		OR-100 Marks

Conduction guidelines: Industry or research internship should include partial/ complete project implementation. Student should be allocated to the research guide in first semester itself and same guide should be continued for the: Industry Internship-/ In house Research Project. Otherwise, the preferences/ choices of the domain should be taken from the students. The guide needs to be allocated based on the preference/ choices. The research project should be assigned to students. In case of Industry Internship, the assigned guide from college must monitor and evaluate the progress of the student. The student must exhibit the continuous progress through regular reporting and presentations and proper documentation. The continuous assessment of the progress needs to be documented unambiguously.

Internship Report

After completion of Internship, the student should prepare a comprehensive report to indicate what he has observed and learnt in the training period. The student may contact Industrial Supervisor/ Faculty Mentor/TPO for assigning special topics and problems and should prepare the final report on the assigned topics. Daily diary will also help mostly in writing the industrial report since much of the information has already been incorporated by the student into the daily diary. The training report should be signed by the Internship Supervisor, TPO and Faculty Mentor. The Internship report will be evaluated based on following criteria:

i. Originality.

ii. Adequacy and purposeful write-up.

iii. Organization, format, drawings, sketches, style, language etc.

iv. Variety and relevance of learning experience.

v. Practical applications, relationships with basic theory and concepts taught in the course

For the list of documents to be submitted after internship, please refer the AICTE Guidelines:

Reference: https://aicte-india.org/sites/default/files/AICTE%20Internship%20Policy.pdf

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MRA23213-Dissertation Stage II

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 16 hrs/week	PR:08	TW-100 Marks
		OR-100 Marks

Guidelines:

In Dissertation Work Stage–II, the student shall consolidate and complete the remaining part of the dissertation which will consist of Selection of Technology, Installations, implementations, testing, results, measuring performance, discussions using data tables per parameter considered for the improvement with existing/ known algorithms/ systems, comparative analysis, validation of results and conclusions. The student shall prepare the duly certified final report of Dissertation in standard format for satisfactory completion of the work by the concerned guide and head of the Department/ Institute. The students are expected to validate their study undertaken by publishing it at standard platforms. The investigations and findings need to be validated appropriately at standard platforms – conference and/or scopus indexed journal. The student has to exhibit continuous progress through regular reporting and presentations and proper documentation of the frequency of the activities in the sole discretion of the PG coordination. The continuous assessment of the progress needs to be documented unambiguously.

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