

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 2026)
[2026 pattern]

A.Y. 2026-2027

Vidya Pratishthan's
Kamalnayan Bajaj Institute of Engineering and Technology, Baramati
Board of Studies: Department of Mechanical Engineering
Syllabus: M. Tech - (Robotics and Automation Engineering)
2026 Pattern w.e.f. AY: 2026-27

SEMESTER-I																
Course Type	Course Code	Course Name	Teaching Scheme			Examination Scheme and Marks							Credits			
			TH	PR	TUT	CAA	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
PCC	MRA26101TH	Advanced Mathematics	4	-	-	20	30	70	-	-	-	120	4	-	-	4
PCC	MRA26102TH	Robot Control System	4	-	-	20	30	70	-	-	-	120	4	-	-	4
PCC	MRA26103TH	Advanced Industrial Robotics and Automation	3	-	-	20	-	70	-	-	-	90	3	-	-	3
MDM	MRA26XXXXTH	Multidisciplinary Minor	2	-	-	10	-	50	-	-	-	60	2	-	-	2
VSEC	MRA26105PR	Skill development lab -1	-	4	-	-	-	-	30	-	30	60	-	2	-	2
Exp. Learn.	MHS26101TH	Research Methodology	3	-	-	30	-	70	-	-	-	100	3	-	-	3
HSSM	MHS26102TH	Indian Knowledge System	2	-	-	20	30	-	-	-	-	50	2	-	-	2
Total			18	4	-	120	90	330	30	-	30	600	18	2	-	20

Multidisciplinary Minor			
MRA26104A	Service Robots	MRA26104B	Wireless Networks
MRA26104C	Signal Processing	MRA26104D	Pneumatic and Hydraulic Control

Important Note:

The In-Semester Examination (ISE) for the following courses will be conducted in an MCQ-based test pattern.
Semester I: Indian Knowledge System



Dr. M. S. Lande
Head of Department



Dr. N.T. Suryawanshi
Institute PG Coordinator


23/03/2026

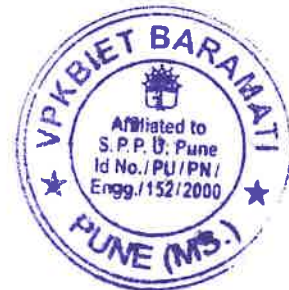
Dr. S. M. Bhosle
Dean Academics



Dr. A. H. Kolekar
Controller of Examination



Dr. S. B. Lande
Principal
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SEMESTER-II																
Course Type	Course Code	Course Name	Teaching Scheme			Examination Scheme and Marks							Credits			
			TH	PR	TUT	CAA	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
PCC	MRA26111TH	Robot Programming	4	-	-	20	30	70	-	-	-	120	4	-	-	4
PCC	MRA26112TH	Advanced Robot Kinematics and Dynamics	4	-	-	20	30	70	-	-	-	120	4	-	-	4
PCC	MRA26113TH	Robot Vision System	4	-	-	20	30	70	-	-	-	120	4	-	-	4
PEC	MRA26114XTH	Program Elective - I	4	-	-	20	30	70	-	-	-	120	4	-	-	4
VSEC	MRA26115PR	Skill development lab -2	-	4	-	-	-	-	30	-	30	60	-	2	-	2
VEC	MSE26116TH	Environmental studies	2	-	-	20	30	-	-	-	-	50	2	-	-	2
HSSM	MHS26111TH	Human rights	2	-	-	30	30	-	-	-	-	60	2	-	-	2
Total			20	4	-	130	180	280	30	-	30	-	20	2	-	22


Program Elective- I			
MRA26114A	Mechatronics Systems and Applications	MRA26114B	Flexible Manufacturing Systems
MRA26114C	Instrumentation and Sensors	MRA26114D	CAD/CAM


Important Note:

The In-Semester Examination (ISE) for the following courses will be conducted in an MCQ-based test pattern.
 Semester II: Environmental Studies, Human Rights

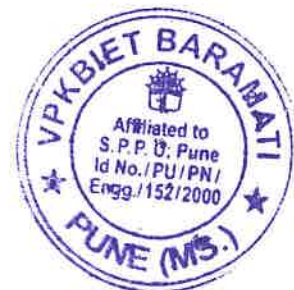

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SEMESTER-III																
Course Type	Course Code	Course Name	Teaching Scheme			Examination Scheme and Marks							Credits			
			TH	PR	TUT	CAA	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
PCC	MRA26201TH	Artificial Intelligence in Robotics	4	-	-	20	30	70	-	-	-	120	4	-	-	4
PCC	MRA26202TH	Soft Computing in Robotics	4	-	-	20	30	70	-	-	-	120	4	-	-	4
PEC	MRA26203XTH	Program Elective-II	4	-	-	20	30	70	-	-	-	120	4	-	-	4
Exp. Learn	MRA26204PR	Dissertation Stage I	-	08	-	20	-	-	50	-	50	120	-	4	-	4
SEC	MRA26205TH	Industrial Management	2	-	-	30	30	-	-	-	-	60	2	-	-	2
SEC	MRA26206PR	Seminar	-	04	-	-	-	-	25	-	25	50	-	2	-	2
AEC/V AC	MHS26201TH	Introduction to Constitution of India	2	-	-	30	30	-	-	-	-	60	2	-	-	2
Total			16	12		140	150	210	75	-	75	650	16	6	-	22

Program Elective II			
MRA26203A	Programming and Data Structure	MRA26203B	MEMS and Microsystems
MRA26203C	Mobile & Autonomous Robots	MRA26203D	Simulation & Modelling

Important Note:

The In-Semester Examination (ISE) for the following courses will be conducted in an **MCQ-based test pattern**.

Semester III: Introduction to Constitution of India, Industrial Management



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SEMESTER-IV																
Course Type	Course Code	Course Name	Teaching Scheme			Examination Scheme and Marks							Credits			
			TH	PR	TUT	CAA	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
Internship/OJT	MRA26211PR	Industry Internship / In-house research project	-	20	-	100	-	-	100	-	100	300	-	10	-	10
Exp. Learn	MRA26212PR	Dissertation Stage- II	-	16	-	50	-	-	100	-	100	250	-	8	-	8
Total				36		150	-	-	200	-	200	550	-	18	-	18
SEC		Introduction to Cyber Security (Online to be taken from the SPPU Portal)	4													4
Total																22



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MRA26101TH-Advanced Mathematics

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs./week	TH:4	Activity Marks - 20 Marks
		In-sem-30 Marks
		End-sem-70 Marks

Prerequisites: Basic Mathematics

Course Objectives: To equip the students with the techniques to understand advanced-level mathematics and its applications that would enhance analytical thinking power, useful in their disciplines.

Course Outcomes (COs): The students will be able to

CO1: Obtain Interpolating polynomials, numerically differentiate and integrate functions, numerical solutions of differential.

CO2: Design, implement and use numerical methods for computer solution of scientific problems involving differential equations.

CO3: Solve homogeneous partial differential equations of n th order and their classification.

CO4: Analyze Complex functions, and conformal mappings, and perform contour integration in their study.

CO5: Apply Laplace transform to solve initial value problems and wave equation.

CO6: Discuss basic ideas of linear regression and correlation, Create and interpret a line of best fit, Calculate and interpret the correlation coefficient, Calculate and interpret outliers.

Course Contents

Unit 1: Numerical Methods (7 hrs)

Solution of polynomial and transcendental equations: Regula-Falsi and Newton-Raphson methods.

Finite differences, Interpolation using Newton's forward and backward difference formulae, Newton's divided difference formula and Lagrange's interpolation formula.

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

Taylor's series method, Euler's method, Modified Euler's method, Runge-Kutta method and Milne's Predictor-Corrector formula. Numerical integration: Trapezoidal rule, Simpson's $(1/3)^{\text{rd}}$ and $(3/8)^{\text{th}}$ rules.

Unit 3: Partial Differential Equations (7 hrs)

Solution of Parabolic and Hyperbolic equations, Implicit & Explicit Schemes, ADI methods, non-linear parabolic equations, Iteration method. Solution of elliptic equation, Jacobi method, Gauss-Seidel & SOR method. Richardson method.

Unit 4: Complex Analysis (7 hrs)

Complex variables, Complex differentiation, Harmonic functions, conformal mapping, Complex integration, Cauchy's integral formulae and Calculus of residues.

Unit 5: Transforms (7 hrs)

Concept of transforms, Fourier transforms, Laplace transforms and its inverse, Laplace transform of special functions, Applications to initial value problem and wave equation using transform techniques.

Unit 6: Regression Analysis

(7 hrs)

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

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. Numerical methods in Engineering and Science, Dr. B.S. Grewal, Khanna Publishers.
6. Elementary Differential Equations and Boundary Value Problems, Boyce and Diprime, Wiley, 2008.
7. Advanced Differential Equations, M. D. Raisinghania, S. Chand Publications, 2008.
8. Complex variable and Applications, 8e, by J. W. Brown and R. V. Churchill (McGraw-Hill)
9. Numerical Methods for Scientific and Engineering Computation Jain, M. K., Iyengar, S. R. K. and Jain, R. K., New Age Pvt. Pub, New Delhi. 2000.

MRA26102TH-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-70 Marks

Prerequisites

Control systems, Engineering mathematics, Basic robotics

Course Objectives

1. To study electromechanical system dynamics
2. To design advanced control systems
3. To understand observers and disturbance rejection
4. To analyze motion and force control
5. To study bilateral control systems

Course Outcomes

- CO1: Model electromechanical systems
- CO2: Design control systems using state-space methods
- CO3: Apply acceleration-based control
- CO4: Implement disturbance observers
- CO5: Design interaction and force control
- CO6: Analyze bilateral control systems

Course Contents

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

MRA26103TH-Advanced Industrial Robotics and Automation

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 hrs./week	TH:3	Activity Marks - 20 Marks
		End-sem-70 Marks

Prerequisites

Basics of manufacturing processes, Fundamentals of robotics, Basic programming knowledge

Course Objectives

1. To understand automation strategies and systems
2. To study industrial robot configurations
3. To analyze robot kinematics
4. To develop robot programming skills
5. To explore industrial applications

Course Outcomes

CO1: Explain automation principles and manufacturing systems

CO2: Classify and analyze industrial robots

CO3: Solve forward and inverse kinematics problems

CO4: Develop robot programs for industrial tasks

Course Content

Unit- I: Introduction

(7)

Definition, automation principles and strategies, scope of automation, socio-economic consideration, low-cost automation, basic elements of advanced functions, Information processing in the 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.

Unit- II: Introduction to Industrial Robots:

(7)

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: Robot Arm Kinematics

(7)

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 –IV: Robot Programming for Industrial applications:

(7)

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.

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.

MDM
MRA26104ATH-Service Robots

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 2 hrs./week	TH: 2	Activity Marks- 10 marks
		End-sem-50 Marks

Prerequisites

Basics of robotics, Sensors and control systems, Basic programming

Course Objectives

1. To understand service robotics concepts and applications
2. To study localization and navigation techniques
3. To analyze path planning methods
4. To explore field and domestic robots

Course Outcomes

- CO1: Explain concepts, applications, and types of service robots.
 CO2: Analyze localization techniques including probabilistic and map-based methods.
 CO3: Apply path planning and navigation strategies for autonomous robots.
 CO4: Evaluate field and domestic robot applications in real-world scenarios.

Course Content

Unit -I: Introduction (6)

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 robot's functions & its operations.

Unit- II: Localization (6)

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 (6)

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 (6)

Ariel robots- Collision Avoidance-Robots for agriculture, mining, exploration, underwater, Civilian, and military applications, nuclear applications, Space applications. Introduction to home automation, domestic robotics, cleaning robots, lawn moving robots, challenges, and applications.

References:

1. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, „Introduction to Autonomous
2. Mobile Robots, Bradford Company, Scituate, USA, 2004
3. Riadh Ziaer (Ed) „The future of Humanoid Robots- Research and applications“, Intech Publications, 2012.

4. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India P Ltd., 2006.
5. Kelly, Alonzo; Iagnemma, Karl; Howard, Andrew, "Field and Service Robotics ", Springer, 2011
6. Groover M. P., "Industrial Robotics: Technology, Programming and Applications, Tata McGraw Hill Publication
7. Taghirad H.D, "Parallel Robots: Mechanics and Control", CRC Press.
8. Moore S. W., Bohm H., and ,Jensen V., "Underwater Robotics: Science, Design & Fabrication", Marine Advanced Technology Education (MATE) Center, 2010
9. Mejia O. D. M., Gomez J. A. E., (eds.), "Aerial Robots: Aerodynamics, Control and Application" InTech Open Publications.
10. Bock T., Linner T., "Robot Oriented Design: Design and Management Tools for the Deployment of Automation and Robotics in Construction", Cambridge University Press,
11. Robotics and Mechatronics for Agriculture, by Zhang D., Wei B., (eds.), CRC Press.
12. Medical Robotics, by Schweikard A., Ernst F., Springer Publications
13. Household Service Robotics, by Xu Y., Qian H., and Wu X., Zhejiang University Press.
14. Springer Handbook of Robotics, by Khatib O., (ed.), Springer Publications.
15. Humanoid Robotics: A Reference, Vadakkepat P., Goswami, A.,Springer Netherlands, 2017. On Road Intelligent Vehicles, by Kala R., Elsevier Publications, 2017

MDM
MRA26104BTH-Wireless Networks

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 2 hrs/week	TH: 2	Activity Marks- 10 marks
		End-sem-50 Marks

Prerequisites

Basic communication systems, Computer networks fundamentals

Course Objectives

1. To understand wireless communication technologies
2. To study mobile network protocols
3. To explore 4G and 5G technologies
4. To analyze modern wireless architectures

Course Outcomes

CO1: Explain wireless LAN technologies and standards (IEEE 802.11, Bluetooth, WiMAX).

CO2: Analyze mobile network layer protocols and routing in ad-hoc networks.

CO3: Evaluate 4G network technologies and their applications.

CO4: Analyze 5G architecture, deployment, and advanced communication techniques.

Course Content

Unit- I : Wireless LAN (6)

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 (6)

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: 4G Networks (6)

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- IV: 5G Networks (6)

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

MDM
MRA26104CTH-Signal Processing

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 2 hrs./week	TH: 2	Activity Marks- 10 Marks
		End-sem-50 Marks

Prerequisites

Engineering mathematics, Signals and systems

Course Objectives

- 1.To understand signals and system representation
- 2.To analyze time-domain and frequency-domain methods
- 3.To study Fourier techniques
- 4.To apply signal processing in engineering

Course Outcomes

- CO1: Classify and represent continuous and discrete signals and systems.
CO2: Analyze LTI systems using convolution and time-domain techniques.
CO3: Apply Fourier series for periodic signal analysis.
CO4: Apply Fourier transform and DFT for frequency-domain analysis.

Course Content

Unit- I: Introduction to Signals & Systems (6)

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 (6)

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 (6)

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

(6)

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

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

MDM
MRA26104DTH-Pneumatic and Hydraulic Control

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 2 hrs/week	TH: 2	Activity Marks-10 Marks
		End-sem-50 Marks

Prerequisites

- Fluid mechanics
- Basic mechanical systems

Course Objectives

1. To understand fluid power systems
2. To study hydraulic components and circuits
3. To analyze pneumatic systems
4. To design electro-hydraulic systems

Course Outcomes

- CO1: Explain fluid power principles and hydraulic pump systems.
 CO2: Analyze hydraulic actuators and control components.
 CO3: Design and evaluate hydraulic circuits and systems.
 CO4: Analyze pneumatic and electro-pneumatic systems and applications.

Course Content

Unit- I: Fluid Power Principles and Hydraulic Pumps (6)

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 (6)

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 (6)

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 (6)

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.

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, Princes and Ashby J. G, "Power Hydraulics", Prentice Hall, 1989.
7. Shanmugasundaram.K, "Hydraulic and Pneumatic controls", Chand & Co, 2006.

MRA26105PR-Skill Development-1

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 4 hrs./week	PR: 2	TW-30 Marks
		OR- 30 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).

MHS26101TH-Research Methodology

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 hrs./week	TH:3	Activity Marks - 30
		End-Sem - 70 Marks

Prerequisites:

Fundamental laws and principles of all subjects, Soft and communication skills.

Course Objectives:

The course has been developed with orientation towards research related activities and recognizing the ensuing knowledge as property.

Course Outcomes:

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

- CO1. Formulate a research problem for engineering and technology domain.
- CO2. Analyze the available literature for given research problem and understand different techniques of data collection.
- CO3. Investigate the statistical and reliability methods of preliminary data analysis and present the results in graphical form.
- CO4. Learner will be able to understand the preliminary data analysis techniques.
- CO5. Learner will be able to understand the advanced data analysis techniques.
- CO6. Understand the importance of technical writing and presentation skills.

Course Content

Unit 1: Introduction

(7)

Definition and Characteristics of Research: Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Philosophy and validity of research. Objective of research. Various functions that describe characteristics of research such as systematic, valid, verifiable, empirical and critical approach.

Unit 2: Literature Review

(7)

Definition of literature and literature survey, Significance of literature survey, Sources of literature, Elements and objectives of literature survey, Styles of literature survey, Strategies of literature survey, Searching the existing literature, Reviewing the selected literature, Writing about the literature reviewed and gap identified, literature analysis, data collection, and interpretation.

Unit 3: Data collection, Measuring, Sampling and Scaling

(7)

Classification of data, benefits and drawbacks of data, evaluation of data, qualitative methods of data collection, methods of qualitative research, Sampling, sample size, sampling strategy, attitude measurement and scaling, types of measurements, criteria of good measurements, classification of scales.

Unit 4 Preliminary data analysis (6)

Testing of hypothesis- concepts and testing, analysis of variance techniques, introduction to non-parametric tests. Validity and reliability, Approaches to qualitative and quantitative data analysis.

Unit 5: Advanced data analysis techniques (6)

Correlation and regression analysis, Introduction to factor analysis, discriminant analysis, cluster analysis, multidimensional scaling, Descriptive statistics, inferential statistics, Multi-dimensional measurement and factor analysis

Unit 6 Technical Writing and Presentation (6)

Effective technical writing, thesis writing, research proposal writing, research paper writing. Significance of report writing, Different steps in writing report, Layout of the research report, Types of reports, Mechanics of writing a research report, Precautions for writing research reports, Presentation skills, tools for technical writing and presentation. Plagiarism, avoiding plagiarism, Research ethics, Tools for plagiarism checking, technical writing and presentation

Text books:

1. Ranjit Kumar (2005), 2nd edition, Research Methodology: A Step by Step Guide for beginners (Pearson Education).
2. C. K. Kothari (2004), 2nd edition, Research Methodology Methods & Techniques (New Age International, New Delhi).
3. T. Ramappa (2016), 2nd edition, Intellectual Property Rights-Law in India (Asia Law House, Hyderabad).

Reference Books:

1. Louis Cohen, Manion, Morrison and Routledge (2017), 8th edition, Research Methods in Education (Taylor & Francis Group- Cambridge University Press India Pvt. Ltd.).
2. John Best and James Kahn (1998), 8th edition, Research in Education (Prentice Hall of India Pvt. Ltd.).
3. Stuart Melville and Wayne Goddard (2001), Research Methodology: An Introduction for Science and Engineering Students. (Juta & Co Ltd.).
4. Benjamine Niebel and Alan Draper (1974), Product Design and Process Engineering, (McGraw Hill International Publishers).
5. Halbert D. J. (2007), 2nd edition, Resisting Intellectual Property (Taylor and Francis Ltd.).
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley (2016), Intellectual Property in New Technological Age ([Stanford Public Law Working Paper No. 2780190](#), Elsevier Publishers).

Activity

An activity can be designed such as to enhance students learning experience. The students need to submit assignment on each unit as part of the activity:

1. Literature Review: Collect the existing literatures on any research idea in engineering/technology and find out the research gap. (Performed by a single student).
2. Report and Seminar Presentation: Prepare the research proposal based on the earlier identified research gap (Report should check in plagiarism and grammarly) and present the idea. (Performed by a single student).

3. Blank format of research proposal: Identify the national and international funding agencies and prepare/print the blank format of research proposal of any one funding agency. (Performed by a single student).
4. Write a report on different citation style and reference style adopted by different publishers.
5. Write a report on case study of any existing patent/copy right/trademark.
6. Collect the information of any one referred peer reviewed journal and write a report based on Abstracting and indexing, H Index, SJR rating, Impact factor, Aims and Scope of the Journal, Guidelines for paper submission etc.

MHS26102TH-Indian Knowledge System

Teaching Scheme	Credit Scheme	Examination Scheme
Theory: 2 hrs./week	TH:2	Activity Marks - 20
		In-sem-30 Marks

Course Objectives:

1. To create awareness about the history and rich cultural heritage of Bharata.
2. To introduce the principles of Vedic mathematics for faster calculations.
3. To explore the contributions of traditional Bharatiya knowledge in science and astronomy.
4. To understand the contributions of traditional Bharatiya knowledge in engineering and technology.

Course Outcomes:

Students will be able to

- CO1. Understand the antiquity of Bharatiya civilization, traditional knowledge systems, ancient education institutions, and contributions to life sciences, healthcare, and philosophy.
- CO2. Apply the principles of Vedic mathematics for efficient problem-solving in arithmetic, algebra, geometry.
- CO3. Analyze the scientific and astronomical advancements of ancient Bharata, including concepts of matter, gravity, aeronautics, and cosmology, and their relevance to modern science.
- CO4. Explore the engineering, technological, and architectural innovations of ancient Bharata.

Course Content

UNIT -I: Bharatiya Civilization and Development of Knowledge System: (6)

Genesis of the land, Antiquity of civilization, the Saraswati-Sindhu Civilization, Traditional Knowledge System, The Vedas, Main Schools of Philosophy, Ancient Education System, the Takṣaśīla University, the Nālandā University. Ethnic Studies, Life Science studies, Agriculture, Ecology and Environment, Ayurveda, Integrated Approach to Healthcare, Medicine, Microbiology, Surgery, and Yoga. Life and work of Rishi's, Brahmavadini.

UNIT-II: Vedic Mathematics:

(8)

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, Quadratic equations, High-Speed Matrix. Algebra.

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, Srauta Sutras and Sulbha Sutras.

UNIT-III: Science, Astronomy**(5)**

Concepts of Matter. Life and Universe, Gravity, Sage Agastya's Model of Battery, Velocity of Light, Vimāna: Aeronautics (Sundar Vimana, Rukma Vimana, Tripur Vimana 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, Archeoastronomy.

UNIT-IV: Engineering, Technology and Architecture:**(5)**

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-Dwārka. Vastu Shastra, Architecture the Root of Civilization and Art work of Bharatiya Knowledge.

Textbooks:

1. Textbook on The Knowledge System of Bharata by Bhag Chand Chauhan,
2. Engineering and Technology in Ancient India by Ravi Prakash Arya
3. History of Science in India Volume-1, Part-1, 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.
6. Mayamatam – Indian Treatise on Housing, Architecture and Iconography (2 volumes), Bruno Daegens, Indira Gandhi National centre for Arts. 2007
7. Glimpse into Kautilya's Arthashastra, Ramachandrudu P., Sanskrit Academy, Hyderabad. 2010
8. Supriya Lakshmi Mishra, Culture and History of Ancient India (With Special Reference of Sudras), 2020.
9. Ranganathananda, Swami. The Message of the Upanishads. Bombay: Bharathya Vidya Bhaven, 1985

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. Advanced Vedic Mathematics, Rajkumar Thakur, Rupa Publications India Pvt. Ltd 2019
6. Vedic Geometry Course, S. K. Kapoor, Lotus Press
7. NPTEL Course: Indian Knowledge System (IKS): Concepts and Applications in Engineering https://onlinecourses.swayam2.ac.in/imb23_mg53/pre view
8. Rigvedadi Bhashya Bhumika: Swami Dayananda Saraswati publisher Arya samaj, Vedic Mission West Midlands.
9. Patanjali Yoga Sutra a commentary by Shri Shri Ravishankar, Arktos media.
10. NPTEL Course: Sohoni Pushkar, Introduction to the History of Architecture in India, IISER Pune, 2020. https://onlinecourses.nptel.ac.in/noc22_ar03/preview.

Course Activity Work: (20 Marks)

- **Attendance:** 5 Marks
- **Vedic Mathematics Test:** 5 Marks
- **Activity:** Participation in courses like NPTEL Art of Living Poster, Presentations, Models Making. 10 Marks

MRA26111TH-Robot Programming

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	Activity Marks- 20 Marks
		In-sem-30 Marks
		End-sem-70 Marks

Prerequisites

- Basics of robotics
- Programming fundamentals

Course Objectives

1. To understand robot programming concepts
2. To learn industrial robot languages
3. To develop programming for applications
4. To analyze robot performance

Course Outcomes

- CO1: Explain robot programming methods
- CO2: Develop programs using VAL/RAPID
- CO3: Implement industrial robot applications
- CO4: Analyze robot motion and cycle time
- CO5: Apply programming for automation tasks
- CO6: Integrate robots with industrial systems

Course Content

Unit -I: Basics of Robot Programming (8)

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, Jogging Types, Robot specifications- Motion commands, end effectors and sensors commands

Unit- II: VAL Language (8)

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 (8)

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 (8)

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 Programming Fundamentals

(8)

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

(8)

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.

MRA26112TH-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-70 Marks

Prerequisites

- Engineering mechanics
- Mathematics (matrices, vectors)
- Basic robotics

Course Objectives

1. To understand robot kinematics
2. To analyze robot dynamics
3. To study motion planning
4. To develop control strategies

Course Outcomes

- CO1: Model robotic systems using D-H parameters
- CO2: Solve forward and inverse kinematics
- CO3: Analyze robot velocity and statics
- CO4: Derive dynamic equations of motion
- CO5: Plan robot trajectories
- CO6: Design control strategies for manipulators

Course Content

Unit I: Elements of robots – links, joints, actuators, and sensors (8)

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 (8)

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 (8)

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-form 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 (8)

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 (8)

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 (8)

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,

MRA26113TH-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-70 Marks

Prerequisites

- Basic programming
- Signals and systems
- Mathematics

Course Objectives

1. To understand image processing fundamentals
2. To analyze vision algorithms
3. To develop object recognition techniques
4. To apply vision in robotics

Course Outcomes

- CO1: Explain image acquisition and processing
- CO2: Apply filtering and transformation techniques
- CO3: Perform image segmentation and feature extraction
- CO4: Implement object recognition algorithms
- CO5: Apply vision techniques in robotics
- CO6: Integrate ROS with vision systems

Course Content

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.

Program Elective-1
MRA26114ATH-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-70 Marks

Prerequisites

Basic electronics, Control systems, Mechanical systems

Course Objectives

1. To understand mechatronics system design
2. To study sensors and actuators
3. To learn microcontrollers and PLCs
4. To apply mechatronics in real systems

Course Outcomes

- CO1: Explain fundamentals of mechatronics systems and design approach.
 CO2: Analyze sensors and transducers used in mechatronic systems.
 CO3: Develop microcontroller-based systems for engineering applications.
 CO4: Design interfacing systems for input-output communication.
 CO5: Develop PLC programs for automation systems.
 CO6: Apply mechatronics concepts in real-world industrial applications.

Course Content

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.

Program Elective-I
MRA26114BTH-Flexible Manufacturing Systems

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures:4 hrs/week	TH:4	Activity Marks -20
		In-sem-30 Marks
		End-sem-70 Marks

Prerequisites

Manufacturing processes, Industrial engineering basics

Course Objectives

1. To understand FMS concepts
2. To study production planning systems
3. To analyze group technology
4. To integrate automation systems

Course Outcomes

- CO1: Explain FMS concepts, components, and layout configurations.
 CO2: Analyze distributed data processing and CAD/CAM integration.
 CO3: Apply group technology and cellular manufacturing principles.
 CO4: Develop production planning and control strategies.
 CO5: Analyze FMS support systems including inspection and material handling.
 CO6: Evaluate computer control systems and FMS applications.

Course Content

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 systems in 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

Program Elective-I
MRA26114CTH-Instrumentation & Sensors

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures:4 hrs/week	TH:4	Activity Marks -20
		In-sem-30 Marks
		End-sem-70 Marks

Prerequisites

Basic electronics, Measurement systems

Course Objectives

1. To understand sensor principles
2. To study measurement systems
3. To analyze DAQ systems
4. To explore intelligent sensors

Course Outcomes

- CO1: Explain sensor-based measurement systems and characteristics.
 CO2: Analyze sensors for displacement, force, and pressure measurement.
 CO3: Analyze sensors for temperature, position, proximity, flow, and level.
 CO4: Design data acquisition systems using ADC/DAC techniques.
 CO5: Apply intelligent sensors in automation systems.
 CO6: Analyze virtual instrumentation and software-based measurement systems.

Course Content

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

Program Elective-I
MRA26114DTH-CAD/CAM

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures:4 hrs/week	TH:4	Activity Marks -20
		In-sem-30 Marks
		End-sem-70 Marks

Prerequisites

- Engineering drawing
- Manufacturing processes
- Basic computer knowledge

Course Objectives

1. To understand CAD/CAM systems
2. To study CIM and automation
3. To analyze process planning
4. To integrate robotics in manufacturing

Course Outcomes

- CO1: Explain fundamentals of CAD/CAM and CIM systems.
 CO2: Analyze production planning and computer-aided process planning.
 CO3: Apply automation and group technology in manufacturing systems.
 CO4: Analyze flexible manufacturing systems and AGVs.
 CO5: Evaluate distributed numerical control and networking systems.
 CO6: Integrate robots within CAD/CAM/CIM environments.

Course Content

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 Computerized 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.

MRA26115PR-Skill Development Lab-2

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 4 hrs./week	PR:2	TW-30 Marks
		OR-30 Marks

1. Study components of an industrial robot (Kuka, Mitsubishi, Fanuc, ABB, etc.) and its DH parameters.
2. Forward kinematics and validation using software (Robo Analyzer/ 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, OpenCV.
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.

MSE26116TH-Environmental Studies

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 2 hrs./week	TH:2	Activity-20 Marks
		End-sem-30 Marks

Course objectives:

The Objective of this course is to impart knowledge of the environment and ecosystems. It also creates awareness among the students about conservation of resources, pollutions and different environmental acts.

Course Outcomes:

After completion of this course, students will be able to,

CO1. Understand the importance of the environment and natural resources.

CO2. Study different ecosystems and prepare a detailed report.

CO3. Identify the causes of pollution and suggest remedial actions.

CO4. Address social issues and understand the various environmental acts.

Course Content

Unit I: Introduction, Multidisciplinary nature of environmental studies: [7]

Definition, scope, and importance. Need for public awareness. Resource types and conservation: Renewable and non-renewable resources, Role of an individual in conservation of natural resources, Equitable use of resources for sustainable lifestyles.

Unit II: Ecosystems & Biodiversity [7]

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 ecosystems. Biodiversity: 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, India as a mega-diversity nation.

Unit III: Environmental Pollution [7]

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 IV: Social Issues and the Environmental acts [7]

Urban problems related to energy, Water conservation, rainwater 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.

References:

1. Suman Gupta, 2024. Environmental studies, S. Chand publication.
2. Gadgil, M., & Guha, R. 1993. This Fissured Land: An Ecological History of India. Univ. of California Press.
3. Odum, E.P., Odum, H.T. & Andrews, J. 1971. Fundamentals of Ecology. Philadelphia: Saunders.
4. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
5. Rosencranz, A., Divan, S., & Noble, M.L. 2001. Environmental law and policy in India. Tripathi 1992.
6. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.

Important Note:

CAA:

Report writing and Poster making & presentation:

Students are required to prepare one report and one poster with presentation on two different activities selected from the list given below. The report and poster should not be based on the same activity.

- i) Record the biodiversity of any visited area and prepare a detailed report.
- ii) Identify the natural resources and ecosystems of your area and prepare a detailed report.
- iii) Identify the sources of pollution in your area and prepare a detailed report.
- iv) Study environmental ethics and environmental acts.

ISE:

The In-Semester Examination (ISE) will be conducted in an **MCQ-based test pattern.**

MHS26111TH- Human Rights

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

Course Objectives:

To introduce students to the concept and evolution of human rights. Understand constitutional provisions related to human rights in India. Develop awareness about human rights in professional and technical environments. Analyze contemporary human rights issues in science, technology, and industry.

Course Outcomes:

After successful completion of the course, students will be able to:

- CO1: Explain the concept, historical development and classification of human rights, including the principles of the Universal Declaration of Human Rights (UDHR).
- CO2: Interpret the human rights provisions in the Indian Constitution and evaluate the role of institutions such as NHRC and human rights courts in protecting vulnerable groups.
- CO3: Apply human rights principles in technical and professional settings, including workplace ethics, labor rights, environmental sustainability, and AI/data privacy issues.
- CO4: Analyze contemporary human rights issues in the global and digital context, including cyber security, intellectual property rights, refugees, and the role of international organizations.

Course Contents

Unit 1: Introduction to Human Rights

[7]

Meaning, Nature and Scope of Human Rights, Evolution and Historical Development Universalism vs Cultural Relativism, Classification: Civil, Political, Economic, Social and Cultural Rights, International Bill of Human Rights, Universal Declaration of Human Rights (UDHR)

Unit 2: Human Rights and Indian Constitution

[7]

Fundamental Rights under Constitution of India, Directive Principles of State Policy, Fundamental Duties, Kinds of Writ Petition, Role of National Human Rights Commission (NHRC), Human Rights Courts in India, Rights of Women, Children, SC/ST and Minorities

Unit 3: Human Rights in Technical and Professional Environment

[7]

Right to Equality and Non-Discrimination in Workplace, Labor Rights and Industrial Safety, Right to Information and Transparency, Environmental Protection and Sustainable Development, National Institutions for the Protection and Promotion of Human Rights, National Human Rights Commission, -Corporate Social Responsibility (CSR), Ethical issues in Engineering, AI & Data Privacy

Unit 4: Contemporary Issues and Global Perspective

[7]

Globalization, Multinational Corporations and Human Rights, Rights in the Digital Era, Cyber Security and Privacy Rights, Implications of Technological Advancements on Society, Expectations from the Technocrats, Effects of Robotics, Automation, and Artificial Intelligence on Daily Life, Surveillance Capitalism, Need of Code of Ethics for Engineers, Content Policing, Content

Moderation, Effect of Emergence of Engineering and Technology on Human Rights in Warfare and Correctional Services

Text Books:

1. Human Rights Law and Practice –By Jatindra Kumar Das, PHI Learning, New Delhi
2. International Law and Human Rights, By Dr. S.K. Kapoor, Published by central law agency, 22nd edition - 2021

Reference Books:

1. Human Rights in Constitutional Law By D.D. Basu, (3rd ed., 2008) published by LexisNexis
2. International Law & Human Rights by Dr. H.O. Agarwal is published by Central Law Publications.
3. Human Rights and Law Justice P.S. Narayana –

Activities for Technical Students

1. Case study on data privacy in AI systems/ content moderation on social media platforms and freedom of expression
2. Analysis of industrial safety standards/social dilemma critically reflecting working of digital platform
3. Report on environmental compliance of industries
4. Study of CSR initiatives of technical companies
5. Assignments on case studies related to technology abuse.
6. Poster designing or Seminars on specific rights.

MRA26201TH-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-70 Marks

Prerequisites

Programming, Mathematics, Basic robotics

Course Objectives

1. To introduce AI concepts
2. To study problem-solving techniques
3. To understand learning and reasoning
4. To apply AI in robotics

Course Outcomes

- CO1: Explain AI concepts and search techniques
- CO2: Apply planning algorithms
- CO3: Analyze probabilistic reasoning models
- CO4: Implement learning techniques
- CO5: Develop expert systems
- CO6: Apply AI in robotic applications

Course Content

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.

MRA26202TH-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-70 Marks

Prerequisites

Mathematics, Programming basics

Course Objectives

1. To introduce soft computing techniques
2. To study fuzzy logic and neural networks
3. To apply optimization methods
4. To use soft computing in robotics

Course Outcomes

- CO1: Explain soft computing concepts
- CO2: Apply fuzzy logic systems
- CO3: Develop neural network models
- CO4: Apply evolutionary algorithms
- CO5: Solve optimization problems
- CO6: Apply soft computing in robotics

Course Content

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.

References:

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

Program Elective-II
MRA26203ATH-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-70 Marks

Prerequisites

- Basic programming (C/C++/Python)

Course Objectives

1. To understand programming fundamentals
2. To study data structures
3. To develop problem-solving skills
4. To apply algorithms

Course Outcomes

- CO1: Explain programming fundamentals and constructs.
- CO2: Implement linear data structures (arrays, stacks, queues).
- CO3: Implement non-linear data structures (trees, graphs).
- CO4: Apply searching and sorting algorithms.
- CO5: Analyze algorithm complexity and efficiency.
- CO6: Develop applications using data structures.

Course Content

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 operations (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 Kruse, 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

Program Elective-II
MRA26203BTH- 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-70 Marks

Prerequisites

- Basic electronics
- Material science

Course Objectives

1. To understand MEMS fabrication
2. To study micro sensors and actuators
3. To analyze microsystems
4. To explore applications

Course Outcomes

- CO1: Explain MEMS fabrication techniques.
 CO2: Analyze micro sensors and actuators.
 CO3: Evaluate microsystem design and integration.
 CO4: Analyze micro-scale physical phenomena.
 CO5: Apply MEMS technology in engineering applications.
 CO6: Develop MEMS-based solutions for real-world problems.

Course Content

Unit -I: Overview of MEMS and Microsystems (8)

Definition, historical development, properties, design and fabrication micro-system, microelectronics, working principle, applications, and advantages of micro-systems. Substrates and wafers, silicon as substrate material, mechanical properties of Si, Silicon Compounds, silicon piezo resistors, Gallium 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, Maskless lithography

Unit -III: Micro Devices (8)

Sensors – classification – signal conversion ideal characterisation 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
8. Sami Franssila, Introduction to Micro fabrication, John Wiley & sons Ltd, 2004.

Program Elective-II
MRA26203CTH- 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-70 Marks

Prerequisites

- Robotics fundamentals
- Control systems
- Programming

Course Objectives

1. To understand mobile robot systems
2. To study localization and mapping
3. To analyze navigation techniques
4. To develop autonomous systems

Course Outcomes

- CO1: Explain mobile robot architectures and kinematics.
CO2: Analyze localization and mapping techniques.
CO3: Apply navigation and path planning algorithms.
CO4: Analyze sensor integration for autonomous systems.
CO5: Develop autonomous robot control strategies.
CO6: Evaluate applications of mobile robots in real-world environments.

Course Content

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 Robotics, 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.

Program Elective-II
MRA26203DTH-Simulation and Modelling

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs./week	TH:4	Activity Marks: 20 Marks
		In-sem-30 Marks
		End-sem-70 Marks

Prerequisites

Mathematics, Programming basics

Course Objectives

1. To understand modeling techniques
2. To study simulation tools
3. To analyze system behavior
4. To validate engineering systems

Course Outcomes

- CO1: Explain system modeling concepts.
- CO2: Develop mathematical models of engineering systems.
- CO3: Perform simulations using appropriate tools.
- CO4: Analyze system behavior using simulation results.
- CO5: Validate models using real-world data.
- CO6: Apply simulation techniques in engineering applications.

Course Content

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", 2nd 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 ", 3rd 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

MRA26204PR-Dissertation Stage I

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 8 hrs./week	PR:4	Course Activity-20 Marks
		TW-50 Marks
		OR-50 Marks

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1. 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 a problem statement, a literature review, a design, a scheme of implementation (Mathematical Model/ SRS/ UML/ ERD /block diagram/ PERT chart) and Layout & Design of the Set-up.
 2. 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 about the selected dissertation topic.
 3. 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.
 4. 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 undertaken, content delivery, presentation skills, documentation, and report.
 5. The students are expected to validate their study undertaken by publishing it on standard platforms.
 6. The investigations and findings need to be validated appropriately at standard platforms – conference and/or peer-reviewed journal.
 7. The student has to exhibit continuous progress through regular reporting and presentations, and proper documentation of the frequency of the activities at the sole discretion of the PG coordination.
 8. 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.

MRA26205TH-Industrial Management

Teaching Scheme	Credit Scheme	Examination Scheme
Lecture: 2 hrs./week	TH:2	Activity Marks-30
		In-Sem-30Marks

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 Content

Unit I: Basics of Management

6 Hrs

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

6 Hrs

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

6 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

6 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

Note: The semester examination will be conducted in the form of objective questions.

MRA26206PR- Seminar

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 4 hrs./week	PR: 2	TW-25 Marks
		OR-25 Marks

Conduction guidelines:

1. This is a 2-credit course aimed at teaching 2nd year MTech students to make research presentations.
2. Each student must 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.

MHS26201TH- Introduction to Constitution of India

Teaching Scheme	Credit Scheme	Examination Scheme
Theory: 2 hrs./week	TH:2	Course Activity-30 Marks
		In-Sem-30 Marks

Course Objectives:

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

Course Outcomes: After successful completion of the course, students will be able to:

- CO1. Understand and explain the significance of Indian Constitution as the fundamental law of the land.
- CO 2. Utilize his fundamental rights in proper sense at the same time identifies his responsibilities in national building.
- CO3. Analyze the Indian political system, the powers and functions of the Union, State and Local Governments in detail
- CO 4. Understand Electoral Process, Emergency provisions and Amendment procedure.

Course Contents

UNIT-I Introduction to Constitution: [7]

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: [7]

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

UNIT-III State and Local Governments: [7]

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 to 74th Amendment.

UNIT-IV Election Emergency and Amendment Provisions [7]

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. D.D. Basu, Introduction to the Constitution of India, LexisNexis, 25th Edition, 2021.

Reference Book:

1. D.D. Basu, Introduction to the Constitution of India, LexisNexis, 25th Edition, 2021.
2. Subhash Kashyap, Our Constitution: An Introduction to India's Constitution and Constitutional Law, National Book Trust, 2019.
3. Bare Act, Constitution of India, Government of India Publications.
4. Merunandan, "Multiple Choice Questions on Constitution of India", 2nd Edition, Meraga Publication, 2007.

Activity: Poster presentation on election provisions in India.

MRA26211PR-Industry Internship/ In-house Research Project

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

Conduction guidelines:

An industry or research internship should include partial/ complete project implementation. Student should be allocated to the research guide in the first semester itself and the 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 preferences/ choices. The research project should be assigned to students. In the case of an Industry Internship, the assigned guide from college has to 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.

MRA26212PR-Dissertation Stage II

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 16 hrs./week	PR:08	Course Activity-50 Marks
		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 the 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.

Introduction to Cyber Security

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 04 hrs/week (Online-University Platform)	TH: 04	Course Activity- Nil
		InSem- Nil
		End Sem-Nil

Introduction to Cyber Security:

This course must be taken through the SPPU Portal. After successful completion, the certificate must be submitted to the department. Completion of this course is mandatory, and the degree will not be awarded if the course is not completed.



Paper No. 25MTIEN2I105

Institute Enrollment Number:



Vidya Pratishthan's
**KAMALNAYAN BAJAJ INSTITUTE OF ENGINEERING & TECHNOLOGY,
BARAMATI**

(An Autonomous Institute Affiliated to SPPU, Pune)

**M. Tech.- I Mechanical (Robotics and Automation) Semester-I (2023 Pattern)
End-Semester Examination Nov./Dec. 2025**

Course Code: MRA23102

Course Name: Robot Control System

Time: 2 Hour

Total Marks: 60

Instructions to Candidates:

1. Verify the question paper received is with correct course name, branch etc.
2. All questions are compulsory.
3. Neat diagrams must be drawn wherever necessary.
4. Assume Suitable data if necessary.
5. The figures on right side indicates the marks.
6. Use of Electronic pocket calculators is allowed.

Q1.

a) Attempt any one

[8]

- i) Define acceleration control. Explain how it differs from position and velocity control, highlighting its advantages in robotic motion control.
- ii) Derive the control law for a dynamic system that ensures finite-time convergence of tracking errors.

b) Attempt any one

[7]

- i) Define equivalent acceleration and equivalent force. Derive the relationship between them using the equations of motion of a robotic system.
- ii) Derive the acceleration control law for a second-order mechanical system and discuss its physical significance.

Q2.

a) Attempt any one

[8]

- i) Explain the working of a position-based disturbance observer. Derive the disturbance estimation equation using position feedback.
- ii) Explain the concept of a compensated plant. Derive the control law for a plant compensated using disturbance observer estimates.

b) Attempt any one

[7]

- i) Describe the architecture of a closed-loop disturbance observer. Analyze its stability and convergence characteristics.
- ii) Define disturbance estimation error. Derive its dynamics and explain the factors affecting its convergence.

Q3.

a) Attempt any one

[8]

- i) Explain the control of push-pull forces in robotic manipulation. Derive the control law and discuss stability considerations.
- ii) Explain grasp force control in robotic hands. Derive the force distribution strategy for stable grasping of an object.

b) Attempt any one

[7]

- i) Define functionally related systems in robotics. Explain how interactions are handled when position and force variables are functionally related.
- ii) Define constrained motion control. Explain how force and motion constraints are handled simultaneously in robotic systems.

Q4.

a) Attempt any one

[8]

- i) Explain the concept of bilateral control without scaling. Derive the control equations and discuss its significance in teleoperation systems.
- ii) Explain about practical implementation issues in bilateral control systems, including delay, noise, observer design, and scaling trade-offs.

b) Attempt any one

[7]

- i) Define transparency in bilateral control. Analyze how scaling and delay affect transparency.
- ii) Explain passivity-based bilateral control in delayed teleoperation systems.
