Department of Mechatronics Engineering

School of Engineering

Faculty of Science, Technology and Architecture

Master of Technology in Industrial Automation & Robotics

Syllabus

MA6101: Applied Numerical Analysis [3 0 0 3]

Mathematical modelling and engineering problem solving: simple mathematical model, conservation laws and engineering. Approximations and round of errors: Accuracy and precision, error definitions, round off errors, truncation errors and Taylor's series. Roots of equations: Bracketing methods, open methods, roots of polynomials applied to engineering problems. Linear algebraic equations: LU decomposition and matrix inversion, special matrices and Gauss Seidel applied to engineering problems. Numerical Differentiation and Integration: Newton Cotes Integration formulas, integration of equations, numerical differentiation applied to engineering problems. Ordinary Differential Equations: RK methods, Boundary value and Eigen value problems. Partial Differential Equations: Finite difference method for elliptic and parabolic equation applied to engineering problems.

References:

1. S.C. Chapra and R.P. Canale, Numerical Methods for Engineers, 8th Edition, McGraw Hill Publication, 2021.
2. S.S. Sastry, Numerical Analysis for Engineers, 5th Edition, McGraw Hill Publication, 2012.
3. G. Cook, Numerical Analysis, Modelling and Simulation, Larsen and Keller Education, 2017.
4. M. K. Jain, S. R. K. Iyengar, R. K. Jain, Numerical Methods for Scientific and Engineering Computation, 6th Edition, New Age International, 2012

MCE6170: Research Methodology [3 0 0 3]

Mathematical tools for analysis, statistical analysis of data, regression analysis, correlation, concept of best fit and exact fit – Lagrange interpolation, Newton divided difference, least square regression. Design of experiment definition, objective, factorial design, designing engineering experiments, ANOVA, Fractional, Full and Orthogonal Experiments, Taguchi methods for robust design, response surface methodology. Engineering Optimization definition, basics of nonlinear optimization, formulation of optimization problems examples, neural network-based optimization, optimization using fuzzy systems. Sampling Techniques: basic terms, Importance of sampling in research, essentials of a good sample, sampling error, standard error of the mean (Standard Deviation), Estimation of parameters, accuracy & precision of estimation, sampling procedure, types/methods of sampling, Central limit theorem, sample size determination, confidence interval and Confidence level. Measurement & Scaling Techniques: - on different types of data, Types of Scales: Ratio, Interval, Ordinal Nominal. Mapping rules, characteristics of a good measurement, sources of error in measurement. Mathematical modelling of Engineering Systems Basic concepts of modelling of Engineering systems – Static and dynamic model – Model for prediction and its limitations, system simulation using tools like MATLAB, SPSS, Minitab, COMSOL, Ansys etc.

References:

1. C. R. Kothari, Research Methodology: methods and techniques, 5th Edition, New Age International Publishers, 2023.
2. J. W. Creswell, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 4th ed., South Asia ed, Sage Publications India, 2014.
3. W. Goddard, S. Melville, Research Methodology: An Introduction for Science and Engineering Students, 2nd ed. Cape Town, South Africa: Juta & Co. Ltd., 2001.
4. R. Ganesan, Research Methodology for Engineers, MJP Publishers, 2011.

MCE6102: Robotics [3 0 0 3]

Introduction: Laws of Robotics, Robot Classifications, Links, Joints, Degrees of Freedom (DOF), Coordinate Systems, Work Volume, Precision, Repeatability, Accuracy, Position & Orientation: Roll, Pitch, Yaw, Overview of End Effector Selection and Serial Manipulators, Kinematics: Forward & Inverse Kinematics: Geometrical and Algebraic Approaches, Transformation Matrices: Translation, Rotation, Euler Angles, Homogeneous Transformation, D-H Convention and Solutions for Kinematics Problems, Dynamics: Kinetic and Potential Energy, Lagrangian and Euler-Lagrange Equations, Newton-Euler Formulation, Jacobian Matrix in Dynamics, Inertia Matrix, Equations of Motion for Robots, Inverse Dynamics, Basic of Trajectory Planning, Case Study.

References:

1. J. J. Craig, Introduction to Robotics: Mechanics and Control, 4th ed., Upper Saddle River, NJ, USA: Pearson Education International, 2018.
2. S. B. Niku, Introduction to Robotics: Analysis, Control, An Indian Adaptation, 2nd ed., New Delhi, India: Wiley, 2016.
3. S. K. Saha, Introduction to Robotics, 1st ed., New Delhi, India: Tata McGraw-Hill Education, 2008.
4. M. Spong, S. Hutchison, and M. Vidyasagar, Robot Modeling and Control, 2nd ed., Hoboken, NJ, USA: John Wiley and Sons Inc., 2006.
5. K. M. Lynch and F. C. Park, Modern Robotics: Mechanics, Planning, and Control, 1st ed., Singapore: Cambridge University Press, 2017.
6. Ghosal, Robotics: Fundamental Concepts and Analysis, 1st ed., New Delhi, India: Oxford University Press, 2014

MCE6103: Advance Control Theory [3 0 0 3]

Non-Linear System- Phase Plane Analysis, Linearization, Describing Function method, Limit Cycle, Controllability and Observability of Non-Linear System, Lyapunov Stability, Discrete control, Kalman Filter, Sliding Mode Control, System Identification, Control Algorithms for MIMO System-Robust, Optimal and Adaptive Control, Robotic Applications- State observation and feedback control in robotic system.

References:

1. R. Burns, Advanced Control Engineering, 1st ed. Oxford, UK: Butterworth-Heinemann, 2001.
2. M. Athans and P. L. Falb, Optimal Control: An Introduction to the Theory and Its Applications, reprint ed. Mineola, NY, USA: Dover Publications, 2006.
3. U. Mackenroth, Robust Control Systems: Theory and Case Studies. Berlin, Germany: Springer Berlin Heidelberg, 2004.
4. T. J. Tarn, Control in Robotics and Automation: Sensor-Based Integration. Oxford, UK: Academic Press, 2011.

MCE6104: Additive Manufacturing [3 0 0 3]

Need for Additive Manufacturing, Generic AM process, stereolithography or 3D-printing, rapid prototyping, the benefits of AM, distinction between AM and CNC machining, other related technologies- reverse engineering technology. Additive Manufacturing Process chain, Metal System, Photo polymerization processes, Powder bed fusion processes, Extrusion-based systems, Printing Processes evolution of printing as an additive manufacturing process, Sheet Lamination Method and Processes, Beam Deposition Processes and Direct Write Technologies. Guidelines for Process Selection, Introduction, selection methods for apart, challenges of selection, example system for preliminary selection, production planning and control. Software issues for Additive Manufacturing, Post- Processing.

References:

1. C. Chee Kai and L. Kah Fai, Rapid Prototyping: Principles & Applications, World Scientific, 2003.
2. Kamrani and E. Abouel Nasr, Rapid Prototyping: Theory & Practice, Springer, 2006.
3. D. T. Pham and S. S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer, 2001.
4. R. Nooran John, Rapid Prototyping: Principles and Applications in Manufacturing, Wiley & Sons, 2006.
5. H. Prasad and A. V. Suresh, Additive Manufacturing Technology, Cengage, 2019.

MCE6105: Intelligent systems [3 0 0 3]

Intelligent agent, structure and architecture of agents, basic elements of fuzzy systems, fuzzification, Fuzzy inference, basics of Supervised learning, reinforcement learning, unsupervised learning and deep Learning, applications of adaptive control, characteristics of cooperative intelligence, Adaptive control Algorithms, Metaheuristic Algorithm's applications , Nature Inspired Algorithms.

References:

1. S. S. V. C. and A. Hareendran, Artificial Intelligence and Machine Learning, 1st ed. New Delhi, India: PHI Learning Pvt. Ltd., 2014.
2. T. J. Ross, Fuzzy Logic with Engineering Applications, 4th ed. Hoboken, NJ, USA: John Wiley & Sons, Ltd., 2016.
3. C. M. Bishop, Pattern Recognition and Machine Learning, 1st ed. New York, NY, USA: Springer, 2006.
4. P. Joshi, Artificial Intelligence with Python, 1st ed. Birmingham, UK: Packt Publishing Ltd., 2017.

MCE6140: Drone Modelling and Control [3 0 0 3]

Definition and history of drones, Types of drones and their applications, Drone components and terminology, Regulations and Guidelines for drone usage, Design considerations for drone airframe and propulsion systems, Selecting and assembling drone components such as motors, batteries, flight controllers, and cameras, Wiring and soldering techniques. Drone Motors and Electronic Speed Controller (ESC): Working, Types: Brush and Brushless Motors, motor sizing and identification, mounting patterns and thread size, Thrust to Weight ratio, KV ratings, advanced motor selection.

References:

1. S. K. Kopparthy, Drone Technology: Theory and Practice, Springer, 2020.
2. D. McLeod, Getting Started with Drone: How to Build, Fly, and Program Your Own Drone, Apress, 2019.
3. M. A. Banks, Building and Flying Electric Model Aircraft, O'Reilly Media, Inc., 2014.
4. G. C. Camara Leal, Flying Robots: An Introduction to Autonomous Aerospace Systems, Springer, 2017.

MCE6141: Signals and Systems [3 0 0 3]

Introduction: Definitions, Overview of specific systems, Classification of signals, Basic operations on signals, Elementary signals and functions, Systems viewed as interconnections of operations, properties of systems. Time domain representations for linear time-invariant systems: Introduction, Convolution: Impulse response representation for LTI systems, properties of the impulse response. representation for LTI systems, Differential and difference equation representations for LTI systems, S-domain transformation using Laplace transform, Fourier representation for signals: The discrete-time Fourier series, continuous-time periodic signals: Discrete-time non-periodic signals: The discrete-time Fourier transform, Z-Transform, The Fourier transform, properties of Fourier representations, Fast Fourier transform.

References:

1. R. Babu, Signals & Systems, 4th ed. Chennai, India: Scitech Publications, 2011.
2. S. Haykin and B. V. Veen, Signals and Systems, 2nd ed. New Delhi, India: John Wiley & Sons, 2002.
3. J. G. Proakis, D. G. Manolakis, and D. Mimitris, Introduction to Digital Signal Processing, 4th ed. New Delhi, India: Prentice Hall, 2006

MCE6142: Cyber physical system [3 0 0 3]

Cyber-Physical Systems (CPS) in the real world, basics of cyber physical system, components of cyber physical system, wireless sensor network, control of CPS: event triggered control, distributed control, control challenges; networked control system (NCS), security of cyber physical systems, case studies.

References:

1. E. A. Lee and S. A. Seshia, Introduction to Embedded Systems: A Cyber-Physical Systems Approach, Latest ed. United Kingdom: MIT Press, 2017.
2. R. Alur, Principles of Cyber-Physical Systems, Latest ed. Cambridge, MA, USA: MIT Press, 2015.
3. M. Wolf, High-Performance Embedded Computing: Applications in Cyber-Physical Systems and Mobile Computing, Latest ed. Amsterdam, Netherlands: Elsevier Science, 2014.
4. D. B. Rawat, S. Jeschke, and C. Brecher, Cyber-Physical Systems: Foundations, Principles, and Applications, Latest ed. Amsterdam, Netherlands: Elsevier Science, 2016.

MCE6143: Mobile Robots [3 0 0 3]

Types of locomotion, hopping robots, legged robots, wheeled robots, stability, manoeuvrability, controllability; Mobile robot kinematics and dynamics: Forward and inverse kinematics, holonomic and nonholonomic constraints, kinematic models of simple car and legged robots, Control theory - Control design basics, Cruise-Controllers, Performance Objectives, trajectory control. Simple robot - State space model, Linearization, LTI system, stability. PID control, basic control algorithms, Sensors for mobile robots - Classification, performance, uncertainty in sensors, wheel sensor, heading sensor, accelerometers, inertial measurement, motion sensor, range sensors, Case Study.

References:

1. R. Siegwart and I. R. Nourbakhsh, Introduction to Autonomous Mobile Robots, 2nd ed., Cambridge, MA, USA: The MIT Press, 2016.
2. P. Corke, Robotics, Vision and Control: Fundamental Algorithms in MATLAB, 1st ed., Springer Tracts in Advanced Robotics, 2017.
3. S. M. LaValle, Planning Algorithms, 1st ed., Cambridge, UK: Cambridge University Press, 2006.
4. S. Thrun, W. Burgard, and D. Fox, Probabilistic Robotics, 1st ed., Cambridge, MA, USA: MIT Press, 2005.
5. E. R. Melgar and C. C. Diez, Arduino and Kinect Projects: Design, Build, Blow Their Minds, 1st ed., 2012.
6. H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki, and S. Thrun, Principles of Robot Motion: Theory, Algorithms, and Implementations, 1st ed., New Delhi, India: PHI Ltd., 2005.

MCE6130: PLC Lab [0 0 4 2]

Basics of ladder logic programming, stepper motor: direction and speed control, traffic light system: open loop and closed loop control, lift control system, controlling of bottle filling system, PLC controlled electro-hydraulic system, PLC controlled electro-pneumatic system, induction motor control: speed and direction, conveyor belt control and minor project.

References:

1. F. D. Petruzella, Programmable Logic Controllers, 4th edition, McGraw- Hills Publications, 2010.
2. J. W. Webb and R. A. Reiss, *Programmable Logic Controllers: Principles and Applications*, 5th ed. New Delhi, India: PHI Learning, 2003.
3. K. Kamel and E. Kamel, *Programmable Logic Controllers: Industrial Control*. New York, NY, USA: McGraw-Hill Education, 2013.

MCE6131: Pneumatics and Hydraulics Lab [0 0 4 2]

Operations of various valves like directional control valves, flow control, valves, pressure control valves and switches like pressure switches, proximity switches. Working principles of hydraulic pumps, hydraulic motors, throttle valves, direction control valves. Operations of timers and counters. Rigging of manual pneumatic/hydraulic and electro-pneumatic/electro-hydraulic circuits using above valves and switches. Manual and electro-hydraulic circuits using above components, Minor Project.

References:

1. E. Anthony, Fluid Power with Applications. New York, NY, USA: Pearson Education, 2003.
2. S. R. Majumdar, Pneumatic Systems: Principles and Maintenance. New Delhi, India: Tata McGraw-Hill, 2000.
3. E. A. Parr, Hydraulics and Pneumatics: A Technician's and Engineer's Guide, 3rd ed. Oxford, U.K.: Butterworth-Heinemann, 2011.
4. J. Parambath, Design of Industrial Hydraulic Systems: In the SI Units. Independently published, 2020.

MCE6132: Design and Modelling Lab [0 0 2 1]

Introduction of 2D model design and 3D CAD parametric design; CREO parametric design: Sketch, Part modelling, Surface modelling, Dimensions and annotation; Assembly; Advanced assembly; Multi-view drawing and reading; Animation; Mechanical part design; Robotic arm part design, Minor Project.

References:

1. I. Zeid, CAD/CAM: Theory and Practice, 2nd ed. New York, NY, USA: McGraw-Hill Education, 2012.

2. R. H. Shih, Parametric Modeling with Creo Parametric 11.0. Schaumburg, IL, USA: SDC Publications, 2024.
3. M. J. Rider, Designing with Creo Parametric 9.0, Mission, KS, USA: SDC Publications, 2022.

MCE6201: Artificial Intelligence [3 0 0 3]

Introduction to AI and intelligent agents. Uninformed search, Heuristic search, stochastic search, adversarial search. Machine Learning: basic concepts, perceptron, neural network, naive bayes, Decision trees, logistic regression, and unsupervised learning. Constraint satisfaction problems, Markov decision processes, reinforcement learning. Logical agents, Bayesian Networks, natural language processing, AI applications.

References:

1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 3rd ed. Upper Saddle River, NJ, USA: Pearson Education, 2015.
2. K. Knight, E. Rich, and B. Nair, Artificial Intelligence, 3rd ed. New York, NY, USA: McGraw-Hill Education, 2012.
3. D. W. Patterson, Introduction to AI and Expert Systems. Upper Saddle River, NJ, USA: Pearson Education, 2007.
4. G. F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving. New Delhi, India: Pearson Education Asia, 2009.

MCE6202: Drives and Automation [3 1 0 4]

Power converters and their operational characteristics, Control of Drives: DC motors, induction motors, BLDC motor, stepper motor, servo motor, PLC integration with pneumatic and hydraulic system and their control, implementation of PID control/optimal control.

References:

1. G. K. Dubey, Fundamentals of Electric Drives, 2nd Ed., Narosa Publishers, 2010.
2. J. Nagrath and D. P. Kothari, Electric machines, 5th Ed., Tata McGraw Hill, 2017.
3. J. W. Webb and R. A. Reis, Programmable Logic Controllers: Principles and Application, 5th Ed., Pearson, 2017.
4. K. Ogata, Modern Control Engineering, 5th Ed., Pearson, 2011.
5. P. A. Andrew, Hydraulics and Pneumatics: A Technician’s and Engineer's Guide, 2nd Ed Butterworth Heinemann, 2011

MCE6203: Machine vision [3 0 0 3]

Image Acquisition and Analysis: Vision system components, Image acquisition and analysis, Image digitization, Image enhancement, restoration, Segmentation, Morphological Operations, image representation and analysis, color image processing. Characteristics feature and techniques for 3D Vision, Motion Estimation and Tracking: Optical Flow estimation, Object tracking with Kalman filtering. Basic idea of localization employing passive markers. Case Studies.

References:

1. R. C. Gonzalez and R. E. Woods, Digital Image Processing, 3rd ed. Upper Saddle River, NJ, USA: Pearson Education, 2008.
2. M. Sonka, V. Hlavac, and R. Boyle, Image Processing, Analysis, and Machine Vision, 2nd ed. Boston, MA, USA: PWS Publishing, 1998.
3. B. Cyganek and J. P. Siebert, An Introduction to 3D Computer Vision Techniques and Algorithms, 1st ed. Hoboken, NJ, USA: Wiley, 2009.
4. E. R. Davies, Machine Vision: Theory, Algorithms, and Practicalities, 3rd ed. London, UK: University of London, 2004.

MCE6204: Sensors and control systems [3 1 0 4]

Sensors and classifications, Construction, Working and Characteristics of Active and Passive Sensors, Data acquisition, Open loop-and closed loop control systems, mathematical modelling, transfer functions, Time response characteristics, stability, Frequency response analysis, State Space Model, Basics of control design, PID, optimal.

References:

1. D. Patranabis, Sensors and Transducers, 2nd ed., New Delhi, India: PHI, 2019.
2. D. V. S. Murty, Transducers and Instrumentation, 3rd ed., New Delhi, India: Prentice Hall India, 2018.
3. K. Shawhney, A Course in Electrical and Electronics Measurements and Instrumentation, 3rd ed., New Delhi, India: Dhanpat Rai & Sons, 2017.
4. J. Nagarath and M. Gopal, Control System Engineering, 5th ed., New Delhi, India: Wiley Eastern, 2018.
5. N. S. Nise, Control Systems Engineering, 7th ed., New Delhi, India: Wiley Eastern, 2020.
6. K. Ogata, Modern Control Engineering, 5th ed., New Delhi, India: Prentice Hall of India, 2018.

MCE6240: Wireless Sensor Networks [3 0 0 3]

Introduction, Single-Node Architecture, Energy Consumption, Operating Systems and Execution, Optimization Goals and figures of merit, Gateway Concepts, Networking sensors, WSN protocols, Wakeup Radio Concepts, Address and Name Management, Routing Protocols, Time Synchronization, Localization and Positioning, Sensor Tasking and Control, Sensor Node Hardware, Programming Challenges, system power management, case studies.

References:

1. H. Karl and A. Willig, Protocols and Architectures for Wireless Sensor Networks. Hoboken, NJ, USA: John Wiley & Sons, 2005.
2. F. Zhao and L. J. Guibas, Wireless Sensor Networks: An Information Processing Approach. San Mateo, CA, USA: Elsevier, 2004.
3. K. Sohraby, D. Minoli, and T. Znati, Wireless Sensor Networks: Technology, Protocols, and Applications. Hoboken, NJ, USA: John Wiley & Sons, 2007.

4. W. Stallings, Wireless Communications and Networks. Upper Saddle River, NJ, USA: Pearson Education, 2005.

MCE6241: Building Automation [3 0 0 3]

Overview of Building Automation, History and evolution of BAS, Importance and benefits of BAS, Components of a BAS, Fundamentals of Control Systems- open-loop and closed-loop, Sensors and actuators; Energy Management Systems (EMS)- Overview of energy management, Role of BAS in energy conservation, Monitoring and controlling energy usage; Future trends in building automation.

References:

1. B. A. Srney, L. Capehart, and T. Middelkoop, Introduction to Building Automation Systems (BASS), Taylor & Francis, 2020.
2. H. Merz, T. Hansemann, and C. Hübner, Building Automation: Communication Systems with EIB/KNX, LON, and BACnet, 2nd ed. Berlin, Germany: Springer-Verlag, 2018.
3. R. A. Panke, Energy Management Systems & Direct Digital Control, Taylor & Francis, 2020.

MCE6242: Robot Path Planning and Control [3 0 0 3]

Configuration space, obstacles space, dimensions, topology, parameterization, transformations, potential functions, obstacle avoidance, gradient descent, local minima problem, navigational potential functions, non-Euclidean potential functions, algorithms, analysis, running time, complexity, completeness. Graph Search A*, Generalized Voronoi Graph (GVG), opportunist path planning, cell decomposition, trapezoidal, Morse cell, visibility-based decompositions. Sampling-based algorithms, the Probabilistic Road Map (PRM), Rapidly Exploring Random Trees (ERT), control-based planning, Case Study.

References:

1. F. Fahimi, Autonomous Robots: Modeling, Path Planning, and Control, 1st ed. Berlin, Germany: Springer, 2009.
2. H. Asada and J. J. Slotine, Robot Analysis and Control. Berlin, Germany: Springer-Verlag, 1998.
3. Y. B. Sebbane, Planning and Decision Making for Aerial Robots, 1st ed. Cham, Switzerland: Springer, 2014.
4. H. Choset and K. M. Lynch, Principles of Robot Motion: Theory, Algorithms, and Implementations, 1st ed. Boston, MA, USA: MIT Press, 2005.

MCE6243: Optimal Control [3 0 0 3]

Introduction, optimal control of discrete-time systems, discrete-time linear quadratic regulator, optimal control of continuous-time systems, continuous-time linear quadratic regulator, tracking problem, discrete-time tracking problem, final-time-free and constrained input control, dynamic programming, bellman's principle of optimality, LQG, reinforcement learning and optimal adaptive, case studies.

References:

1. B. D. O. Anderson and J. B. Moore, Optimal Control: Linear Quadratic Methods. Mineola, NY, USA: Dover Publications, 2007.
2. F. L. Lewis, D. Vrabie, and V. L. Syrmos, Optimal Control. Hoboken, NJ, USA: Wiley & Sons, 2012.
3. L. M. Hocking, Optimal Control: An Introduction to the Theory with Applications. Oxford, UK: Clarendon Press, 1991

MCE6251: MEMS and NEMS [3 0 0 3]

Introduction to MEMS and NEMS and Microsystems: Evolution of micro and nano fabrication, microelectronics, Materials for MEMS and NEMS: Substrates and wafers, Packaging materials; Micro and Nano fabrication Processes: Lithography processes, Ion implantation, Diffusion, Oxidation, Chemical and Physical fabrication process, Deposition by Epitaxy, Etching, Surface micromachining. Working principles of Microsystems; Micro and Nano sensors; Micro and Nano actuators; Scaling laws in miniaturization: Scaling in geometry, Scaling in rigid body dynamics, Scaling in electrostatic, electromagnetic forces, Scaling in electricity, Scaling in heat transfer and fluid mechanics. application in robotics and other industries.

References:

1. T. R. Hsu, MEMS and Microsystems: Design and Manufacturing, 2nd ed. New Delhi, India: Tata McGraw-Hill, 2008.
2. C. Liu, Foundations of MEMS, 2nd ed. Upper Saddle River, NJ, USA: Pearson, 2012.
3. M. J. Madou, Fundamentals of Microfabrication: The Science of Miniaturization, 2nd ed. Boca Raton, FL, USA: CRC Press, 2002.
4. W. Menz, J. Mohr, and O. Paul, Microsystem Technology. Weinheim, Germany: Wiley-VCH, 2008

MCE6252: Production and Operations Management [3 0 0 3]

Operations Strategy in a global economy, Operations Management and Productivity, Types and Characteristics of Manufacturing and Service Systems, Product Design. Introduction to Forecasting, Introduction to Time-series forecasts, Extrapolative methods Causal Methods of forecasting, Qualitative Methods of Forecasting, Introduction to Inventory Management, Various costs involved in inventory management, Models of Inventory Management, Inventory Control and Supply Chain Management, Modern Quality Management, Total Quality Management, Statistical Concepts in Quality Control, JIT Manufacturing, Lean Manufacturing, Kanban Production System and Lean Philosophy. Maintenance Management, Total Productive Maintenance, Introduction to Project Management, PERT and CPM.

References:

1. W. J. Stevenson, Operations and Supply Chain Management, 14th ed. New York, NY, USA: McGraw-Hill, 2025.
2. N. Gaither and G. Frazier, Operations Management, 9th ed. Boston, MA, USA: SouthWestern/Thomson Learning, 2002.

3. R. B. Chase and F. R. Jacobs, Operations Management for Competitive Advantage, 11th ed. New York, NY, USA: McGraw-Hill/Irwin, 2005.

MCE6253: Drone Applications [3 0 0 3]

Overview of commercial and industrial drone applications, Case studies and examples of successful drone deployments, GPS based navigation system, Drone Camera Systems, Agriculture application, Drone Delivery, Future trends and developments in the drone industry, Case Study.

References:

1. K. Sundar and R. V. Rajakumar, Multicopters: Principles and Applications, Springer, 2021.
2. E. Tooley, Practical Drones: Building, Programming, and Applications, Apress, 2021.
3. D. Saxby, Drone Aerial Photography and Video: Techniques and Stories from the Field, Cengage Learning, 2018.

MCE6254: Smart Manufacturing [3 0 0 3]

Definition and scope of Smart Manufacturing, Evolution of manufacturing technologies, Industry 4.0 principles and components, Overview of traditional vs. smart factories, Internet of Things (IoT) and its applications in manufacturing, Artificial Intelligence and Machine Learning in process optimization, Big Data Analytics for predictive and prescriptive maintenance, Robotics and Automation in smart production lines, Understanding digital twins and their role in manufacturing, Cyber-Physical Systems (CPS) and their architecture, Case studies on CPS implementation in manufacturing, Data acquisition and sensor technologies, Statistical methods and data visualization, Process optimization using realtime data, Case studies: Manufacturing analytics in action, 3D printing technologies.

References:

1. M. Soroush, M. Baldea, and T. F. Edgar, *Smart Manufacturing: Concepts and Methods*. Amsterdam, The Netherlands: Elsevier, 2020.
2. A. Gilchrist, *Industry 4.0: The Industrial Internet of Things*. Berkeley, CA, USA: Apress, 2016.
3. T. Y. Kheng, Ed., *Smart Manufacturing: When Artificial Intelligence Meets the Internet of Things*. London, U.K.: IntechOpen, 2021.

MCE6230: Robotics Lab [0 0 2 1]

Forward and inverse kinematics of a robot, velocity analysis, Mobile robot, Dynamics of Robot Manipulators, Control of Robot Manipulators: PID control, Adaptive Control, Robot Path-Planning, Minor Project.

References:

1. Y. Kozyhev, Industrial Robots Handbook, Moscow, Russia: MIR Publications, 2022.
2. S. B. Niku, Introduction to Robotics: Analysis, Control Applications, NJ, USA: Wiley Publications, 2020.
3. S. G. Tzafestas, Introduction to Mobile Robot Control. Amsterdam, Netherlands: Elsevier, 2013.

4. M. W. Spong and M. Vidyasagar, Robot Dynamics and Control, 2nd ed. Hoboken, NJ, USA: Wiley Publications, 2009

MCE6231: Drives and Automation Lab [0 0 2 1]

Power converters and their operational characteristics, Control of Drives: DC motors, induction motors, BLDC motor, stepper motor, servo motor, PLC integration with pneumatic and hydraulic system and their control, implementation of PID control/optimal control, Minor Project.

References:

1. G. K. Dubey, Fundamentals of Electric Drives, 2nd Ed., Narosa Publishers, 2010.
2. J. Nagrath and D. P. Kothari, Electric machines, 5th Ed., Tata McGraw Hill, 2017.
3. John W. Webb and Ronald A. Reis, Programmable Logic Controllers: Principles and Application, 5th Ed., Pearson, 2017.
4. Katsuhiko Ogata, Modern Control Engineering, 5th Ed., Pearson, 2011.
5. P. A. Andrew, Hydraulics and Pneumatics: A Technician’s and Engineer's Guide, 2nd Ed Butterworth Heinemann, 2011.