DEPARTMENT OF MECHANICAL ENGINEERING

Scheme of Instruction
and
Syllabus of

B.E. HONOR
IN
Mechanical Engineering

With effected from the Academic Year 2024-2025

UNIVERSITY COLLEGE OF ENGINEERING
(AUTONOMOUS)
OSMANIA UNIVERSITY
HYDERABAD–500007, TELANGANA.

SCHEME OF INSTRUCTION EXAMINATION
B.E Honors in Mechanical Engineering

S.No.	Semester	Course Code	Course Title	Scheme of Instruction			Contact hrs/wk	Scheme of Examination		Credits
				L	T	P		CIE	SEE	
1	V-Sem	HR501ME	Flexible Manufacturing Systems	3	-	-	3	40	60	3
2	VI-Sem	HR601ME	Industry 4.0	3	-	-	3	40	60	3
3	VI-Sem	HR602ME	Planar Multibody Dynamics	3	-	-	3	40	60	3
4	VII-Sem	HR701ME	Fundamentals of Two-Phase flows	3	-	-	3	40	60	3
5	VII-Sem	HR702ME	Design of Mechatronics System	3	-	-	3	40	60	3
6	VIII-Sem	HR851ME	**MR-Project Work**	-	-	6	6	50	100	3
Total				15	0	6	21	250	400	18

Note:

The **Honor programme** in **B.E Mechanical Engineering** is offered to the students of Mechanical Engineering, from V-Semester onwards of the University College of Engineering (Autonomous), Osmania University, Hyderabad

Course Code	Course Title							Course Type
HR501ME	**FLEXIBLE MANUFACTURING SYSTEMS**							**Core**
Prerequisite	**Contact hours per week**				**Duration of SEE (Hours)**	**Scheme of Evaluation**		**Credits**
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

- To learn the evolution of flexible manufacturing systems, layouts human resources involvement.
- To know the manufacturing driving force, design scheduling of jobs, classification and coding technique.
- To understand the working of automated movement, storage systems, tool management, fault detection and relationship with workstations.

Course Outcomes: After completion of the course student will be able to

1. Classify and distinguish FMS layouts and planning preparation for FMS
2. Identify design, manufacturing at tributes and human resources involvement
3. Explain processing stations and material handling systems used in FMS environments
4. Analyze tool management in FMS
5. Evaluate the relationship with FMS workstations and networks

UNIT-I

Evolution of Manufacturing Systems: FMS definition and description, General FMS considerations, Manufacturing cells, Cellular versus Flexible Manufacturing. Systems Planning: Objective, introduction planning, preparation guidelines, the project team, supplier selection, system description and sizing, facility preparation planning, FMS layouts, Just in- time manufacturing, Benefits and relationship to FMS, quality and quantity application principles.

UNIT-II

Group Technology: Concepts, classification, coding, Reasons for Adopting Group Technology, Production Flow Analysis, Benefits and relationship to FMS, Problems in Group Technology, Quantitative Analysis in Cellular Manufacturing, Human Resources: staff considerations, team work, communication and involvement, the supervisor's role, personnel selection, job classifications, employee training.

UNIT-III

Automated Material Movement and Storage Systems: AGVs, Robots. Automated Storage and retrieval Systems, Conveyers and pallet floatation systems, queuing Carrousels and automatic work changes, Coolant and chip disposal and recovery systems, Cleaning and Deburring, Wash station types and operation description, Deburring station types and operation description, Importance to Automated Manufacturing, Coordinate measuring machines & types of CMM.

UNIT-IV

Cutting Tools and Tool Management: Introduction, getting control of cutting tools, Tool Management, tool strategies, data transfer, tool monitoring and fault detection, Experimental Setup and Data Collection, Work holding considerations, Fixture support and location principles, Fixture considerations in an FMS environment.

UNIT-V

FMS Networks: computer Hardware, Software, Communications networks, FMS implementation, hardware configuration, programmable logic controllers, cell controllers, general phases of simulation, reasons to integrate FMS computer system to a central host computer, maintenance concerns.

Suggested Reading:

1. Groover, M.P., "Automation, Production Systems and CIM", Third Edition, Prentice Hall India, 2012.
2. Parrish, D.J," Flexible Manufacturing",NewEdition, Butter Worths, Heinemann, Oxford, 1993
3. H.K. Shivanand,M.M.BenalandV.Koti,"Flexible Manufacturing System",First Edition, New Age International (P) Ltd., 2006.
4. Kusiak, A,"Intelligent Manufacturing Systems",First Edition,PrenticeHall, 1990
5. WilliamW.Luggen.,"Flexible Manufacturing Cells and Systems", FirstEdition, Prentice Hall, Englewood, 1991.

Course Code	Course Title							Course Type
HR601ME	**INDUSTRY 4.0**							**Core**
Prerequisite	**Contact hours per week**				**Duration of SEE**	**Scheme of Evaluation**		**Credits**
	L	**T**	**D**	**P**	**(Hours)**	**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:
The course is taught with the objectives of enabling the student to:
Understand the basic concepts, identify parts and classify aerial robots.
Able to understand fundamentals of aerial robots.
Understand and apply knowledge on modelling and dynamics for aerial robot applications.
Understand and apply navigation & path planning in aerial robots.
Understand system integration for aerial robots.

Course Outcomes: On completion of this course, the student will be able to do:
Interpret the meaning and scope of Industry 4.0.
Illustrate the role of Data Analytics and IoT in a Manufacturing Industry.
Recognize the role of Robotics and Augmented Reality in the implementation of Industry 4.0
Identify the role of Additive Manufacturing Technology in Industry 4.0 and interpret the working of various AM technologies and their applications.
Analyze the role of virtual factory, digital traceability and Cyber Security in the implementation of Industry 4.0.

UNIT–I
Introduction: Definition, Main concepts and components of Industry 4.0, Proposed Framework of Industry 4.0, Smart and Connected Product Business Models, Smart Manufacturing, Lean Production Systems for Industry 4.0, The changing role of Engineering Education in Industry 4.0 Era, Industry 4.0 laboratories, Opportunities and Challenges of Industry 4.0, Future Skills required by Workers in the Industry 4.0 Era, Strategies for competing in an Industry 4.0 world.

UNIT – II
Data Analytics and Internet of Things in Manufacturing: Introduction to data analytics, Techniques used for Predictive Analytics, Forecast Accuracy Calculations, A real world Case Study; Introduction to IoT, Examples for IoTs Value Creation in Different Industries. IoTs Value Creation Barriers: Standards, Security and Privacy Concerns.

UNIT – III
Robotics and Augmented Reality in Industry 4.0: Introduction, Recent Technological Components of Robots: Advanced Sensor Technologies, Artificial Intelligence, Internet of Robot Things, Cloud Robotics, Cognitive Architecture for Cyber-Physical Robotics, Industrial Robotic Applications. Introduction to Augmented Reality: Augmented Reality Hardware and Software Technology, Industrial Applications of Augmented Reality

UNIT–IV
Additive Manufacturing Technologies and Applications: Introduction, Additive Manufacturing (AM) Technologies: Stereolithography, 3DP, Fused Deposition Modeling, Selective Laser Sintering, Laminated Object Manufacturing, Laser Engineered Net shaping, Advantages and Disadvantages of Additive Manufacturing. Applications of Additive Manufacturing in Medical, Surgical Planning, Implant and Tissue Design, Automotive, Aerospace, Electronics, Education and

Oceanography. Impact of AM Technologies on society: Impact on health care, Environment, Manufacturing and Supply Chain.

UNIT–V

Virtual Factory, Digital Traceability and Cyber Security: Introduction to Virtual Factory, Virtual Factory Software, Limitations of Commercial Software; Introduction to Digital Traceability, Digital Traceability Technologies, Architectural Framework, Applications, Project Management in Digital Traceability; Introduction to Cyber Security, Security Threats and Vulnerabilities of IoT, Industrial Challenges, Evolution of Cyber Attacks, Cases on Cyber Attacks and Solutions, Strategic Principles in Cyber Security, Cyber Security Measures.

Suggested Readings:

1. Alp Ustundag and Emre Cevikcan, Industry 4.0: Managing The Digital Transformation Springer Series, 1st edition, 2018.
2. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 1st edition, 2019.
3. DrIng. Klaus Schwab, The fourth Industrial Revolution, Penguin Publisher; 1st edition, 2017.
4. Pascual D G, Handbook of Industry 4.0 and Smart Systems, Taylor and Francis, 2020.
5. Kumar K, Digital Manufacturing and Assembly Systems in Industry 4.0, Taylor and Francis, 2020.

Course Code	Course Title							Course Type
HR602ME	**PLANAR MULTIBODY DYNAMICS**							**Core**
Prerequisite	**Contact hours per week**				**Duration of SEE (Hours)**	**Scheme of Evaluation**		**Credits**
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

The course is taught with the objectives of enabling the student to:

- Learn the fundamentals of planar kinematics & dynamics
- Learn to draw FBD for various mechanical systems
- Understand the analysis based on body, joint and point formulation
- Understand the effect of contact and impact on the dynamic analysis of systems
- Use numerical methods to derive forward and inverse dynamics of dynamic systems

Course Outcomes: On completion of this course, the student will be able to do:

1. Understand the importance of kinematics and dynamics in the analysis of mechanical systems
2. Draw free body diagrams for mechanical systems under different loading conditions
3. Develop dynamic models for mechanical systems based on Joint, point and body coordinate formulation
4. Use numerical methods to solve the dynamics effects in mechanical systems
5. Apply numerical methods to analyse various mechanisms

UNIT-I

Multibody Systems: Introduction, Multibody Mechanical Systems, Types of Analyses, Fundamentals of Planar Kinematics: Kinematics of a Particle, Rigid Body, Velocity and Acceleration of a Body, Degrees of Freedom, Constraint Equations, Kinematic Joints, Fundamentals of Planar Dynamics: Newton's Laws of Motion, Particle Dynamics, Dynamics of a System of Particles, Rigid body Dynamics, Moment of a Force and Torque, Centroidal Equations of Motion, Non-centroidal Equations of Motion Multibody Dynamics, Applied Forces, Reaction Forces, Friction Force, Wheel and Tire, Motor and Driver, Work and Energy.

UNIT-II

Vector Kinematics: Types of Vectors, Open-Chain Systems, Closed-Chain Systems, Slider- Crank Mechanism, Four-Bar Mechanism, Six-Bar Quick-Return Mechanism, Six-Bar Dwell Mechanism, Complete Kinematic Analysis Free-Body Diagram, FBD Examples, Two-Body System (Unconstrained), Two-Body System (Constrained), Sliding Pendulum, Slider-Crank Mechanism, Four-Bar Mechanism, Equations of Motion, Force Analysis, Slider-Crank Mechanism, Four-Bar Mechanism, Generalization of Force Analysis.

UNIT-III

Body-Coordinate Formulation: General Procedure, Kinematic Joints, Revolute (Pin) Joint, Translational (Sliding) Joint, Revolute–Revolute Joint, Revolute–Translational Joint, Rigid Joint, Simple Constraints, Circular Disc, Driver Constraints, System Jacobian, Unconstrained Equations of Motion, Constrained Equations of Motion, Reaction Forces and Lagrange Multipliers, Total Energy, Body coordinate simulation examples: Double A-Arm Suspension, MacPherson Suspension, cart, Conveyor Belt and Friction, Rod Impacting Ground Joint- Coordinate Formulations,

Joint coordinate Formulation: Joint Coordinate and Joint Reference Point, Recursive Kinematics, Open-Chain Systems, Closed-Chain Systems, Cut-Joint Constraints, Equations of Motion, Jacobian Matrix, Initial Conditions, Reaction Forces, Driver Constraint,

UNIT-IV

Point-Coordinate Formulation: Classical Method, Primary and Stationary Points, Constraints, Length angle, simple Constraints, Equations of Motion, Force and Torque Distribution, Mass Distribution, Mass Condensation, Two Primary Points, Three Primary Points, Force and Mass Addition.

Contact and Impact: Piecewise Analysis, Momentum, Impact of Particles, Unconstrained Bodies, Constrained Bodies, Impact with Friction, Continuous Analysis, A Body Contacting a Rigid Surface, Two-Body Contact.

UNIT-V

Kinematics and Inverse Dynamics: Kinematic Analysis, Nonlinear Algebraic Equations Forward Dynamics: Unconstrained Formulation, Initial Value Problems, Runge–Kutta Algorithm, General Procedure, Constrained Formulation, Constraint Violation Stabilization Method, Coordinate Partitioning Method, Penalty Method,

Joint-Coordinate Method: Momentum Method, Contact and Impact, Combined Analyses, Complementary Analyses: Static Analysis, Static Equilibrium, Initial Condition Correction, Redundant Constraints,

Applications: Film-Strip Advancer, Web-Cutter Mechanism, Six-Bar Quick-Return Mechanism, Six-Bar Dwell Mechanism, Windshield Wiper Mechanism, Double A-Arm Suspension, MacPherson Strut Suspension, Half-Car, Mountain Bike, Creeping Robot,

Suggested Readings:

1. Parviz Nikravesh, Planar Multibody Dynamics, Taylor & Francis, 2nd edition
2. Shabana A. A., Computational dynamics, John Wiley & Sons.
3. Roberson R. E., and Richard S., Dynamics of multibody systems, Springer-Verlag.
4. Shabana A. A., Dynamics of multibody systems, Cambridge University press.
5. Bauchau O. A., Flexible multibody dynamics, Vol. 176. Springer.
6. Chaudhary H., and S K Saha , Dynamics and balancing of multibody systems,. Springer

Courses suggested for Honors in Mechanical Engineering

1. Flexible Manufacturing Systems
2. Planar Multibody Dynamics
3. Fracture Mechanics
4. Advanced Manufacturing Techniques
5. Design for Additive Manufacturing
6. Industry 4.0
7. Cryogenic Engineering
8. Fluid Flow and Gas Dynamics + CA (FFGD+CA)
9. Fundamentals of Two-Phase flows
10. Advanced Energy Systems
11. Vibration Analysis & Condition Monitoring
12. Industrial Automation for Manufacturing
13. Flexible Manufacturing Systems
14. Advanced Casting and Joining Processes
15. Fluid Power Systems
16. Nonlinear Control Systems
17. Computer Control of Mechanical Systems
18. Design of Mechatronics System
19. Project Work

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