IPS Academy, Institute of Engineering & Science

(A UGC Autonomous Institute, Affiliated to RGPV, Bhopal)

Scheme & Syllabus

Mechanical Engineering Department

Minor in Mechanical Engineering

(To be offered to students of other departments excluding Mechanical Engineering Department)

S. No.	Semester	Subject Code	Subject Name	Contact Hours Per Week			Total Credits
				L	T	P	
1	V		Mechatronics	3	0	0	3
2	VI		Robotics and 3D Printing	3	0	2	4
3	VII		Electric & Hybrid Vehicles	3	0	2	4
4	VIII		Introduction to Microfluidic Engg.	3	0	2	4
Total				**12**	**0**	**6**	**15**
Total Academic Engagement and Credits				**18**			**15**

*L: Lecture, T: Tutorial, P: Practical

IPS Academy, Institute of Engineering & Science

(A UGC Autonomous Institute, Affiliated to RGPV, Bhopal)

Scheme & Syllabus

Mechanical Engineering Department

	Mechatronics	**3L: 0T: 0P (03 Hrs)**	**03 Credits**

Pre-requisite's: Fundamentals of Mechanical Engineering and Electronics Engineering.

Course Objective's:

• The course trains students to practice Mechatronics Engineering in various areas of industrial and non-industrial automation.

Course Content:

Module 1 **(08 Hrs)**

Introduction: Definition of Mechatronics, Multi-disciplinary scenario, origins. Evaluation of Mechatronics, An over view of Mechatronics, Design of Mechatronics system. Measurements system and function of main elements of measurement systems. Need for Mechatronics in industries. Objectives, advantages and disadvantages of Mechatronics.

Module 2 **(08 Hrs)**

Review of Transducers and Sensors: Definition and classification of transducers and sensors, Principle of working and applications of light sensors, proximity sensors and Hall Effect sensors, Review of fundamentals of electronics, Data conversion devices.

Module 3 **(09 Hrs)**

Microprocessor: General definitions of microprocessors, Microprocessor based digital control. Digital number system, binary and hexadecimal number system, basic elements of control systems. Microcontrollers, applications, classification of micro controllers. Difference between microprocessor and micro controllers, Programmable Logic Controllers.

Module 4 **(10 Hrs)**

Mechanical Actuation System: Cams, Gear trains, Belt and chain drives, Bearings. Hydraulic and Pneumatic Actuation System: Introduction to Hydraulic and Pneumatic Systems, Valves, Classifications, Pressure Control Valves – Pressure relief valves, Pressure regulating/reducing valves Directional Control valves, Flow control valves. Electrical Actuation System: Electrical systems, Solid State Switches, Solenoids, D.C. motors, A.C. motors, Stepper motors, servomotors.

Module 5 **(07 Hrs)**

Signal Conditioning: Concept, necessity, op-amps, protection, filtering, wheat stone bridge – Digital Signals – Multiplexer. Data acquisition – Introduction to digital signal processing – Concepts and different methods.

Course Outcome:

After completion of the course student will be able:

1. Explain the design of Mechatronics system and its applications.
2. Identify appropriate sensors and transducers for an engineering application.
3. Acquire knowledge about microprocessor and classify the micro-controller.
4. Interpret different types of actuator and actuator system.
5. Explain the concept of digital signals and elements of data acquisition.

Text Books:

1. R. K Rajput, "Mechatronics," Laxmi Publications
2. HMT ltd. Mechatronics, Tata McGraw-Hill, New Delhi, 1988.

Reference Books:

1. Mechatronics – Principles, Concepts and applications – Nitaigour and Premchand, Mahilik – Tata McGraw Hill -2003.
2. Mechatronics – W. Bolton, Pearson Education Asia -3rd Edition.
3. Introduction to mechatronics and measurement systems –David G. Alciatore & Michel BiHistand – Tata McGraw Hill –2000.
4. Mechatronics – H.D. Ramachandra – Sudha Publication -2003 Mechatronics by HMT Ltd. – Tata McGraw Hill -2000.
5. Mechatronics System design by Devadas Shetty and Richard A. Kark – Thomas Learining - 1997.
6. Mechatronics an Introduction by Robert H Bishop – CRC.
7. Mechatronics systems Fundamentals by Rolf Isermann – Springer.

IPS Academy, Institute of Engineering & Science

(A UGC Autonomous Institute, Affiliated to RGPV, Bhopal)

Scheme & Syllabus

Mechanical Engineering Department

	Robotics and 3D Printing	**3L:0T: 2P (05 hrs)**	**04 Credits**

Pre-requisite's:
Basic Knowledge of Engineering Graphics.

Course Objective's:

- To develop the student's knowledge in various robot structures and their workspace.
- To develop student's skills to understand kinematics of robot systems.
- To provide Fundamental knowledge and skills associated with robot control.
- To introduce students the basics of additive manufacturing/3D Printing and its applications in various fields, reverse engineering techniques.
- To familiarize students with different processes in 3D Printing Technologies.

Course Content:

Module 1 **(09 Hrs)**

Introduction of Robots: Classification of robots, Present status and future trends. Basic components of robotic system. Basic Terminology- Accuracy, Repeatability, Resolution, Degree of freedom. Mechanisms and transmission, End effectors, Grippers-different methods of gripping, Mechanical grippers-Slider crank mechanism, Screw type, Rotary actuators, Cam type gripper, Magnetic grippers, Vacuum grippers, Air operated grippers; Specifications of robot.

Module 2 **(07 Hrs)**

Drive systems and Sensors: Drive system- hydraulic, pneumatic and electric systems, Sensors in robot – Touch sensors, tactile sensor, Proximity and range sensors, Robotic vision sensor, Force sensor, Light sensors, Pressure sensors.

Module 3 **(7 Hrs)**

Introduction and Classification: Additive Manufacturing (AM) processes, AM evolution, Distinction between AM & Computer Numeric Control (CNC) machining, Advantages, Limitation and Future Scope of AM.

Module 4 **(10 Hrs)**

Classes of Materials for 3D Printing and its Processing Mechanisms: ABS plastic, PLA, Polyamide (nylon), Glass Filled Polyamide, Stereo lithography Materials (Epoxy Resins), Silver, Titanium, Steel, Wax, Photopolymers and Polycarbonate, Pure Metals Powder, Alloys Powder, Multi Component Metals/Alloys Powder Mixture.

Module 5 **(09 Hrs)**

Software and Tools: C++, Python, CAD Software like AutoCAD, Solid works, Sketch up, Tinker CAD, Fusion 360 etc., Slicing Software Voxelizer, Cura etc., Steps of 3D Printing,

Application of Robotics and 3D Printing: Biomedical implants, Metal Components, Aerospace, Automobile etc. and case studies.

Course Outcomes:

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

1. Demonstrate the robot anatomy with joint notations and applications.
2. Familiarize with the most common robot sensors and understand fundamental sensor processing algorithms and their engineering trade-off and identify and use of different types of drives and end effectors required for specific applications.
3. Demonstrate the knowledge of Additive Manufacturing and Rapid Prototyping technologies.
4. Apply steps of 3D Printing using tools and software.
5. Compare Additive and Subtractive manufacturing.

Text Books:

1. Ian Gibson, David W. Rosen, Brent Stucker , “Additive Manufacturing Technologies” , Springer, 2009.
2. Chua C. K., Leong K. F., and Lim C. S., “Rapid Prototyping: Principles and Applications”, Second Edition, World Scientific Publishers 2003.
3. Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, “Industrial Robotics, Technology programming and Applications", McGraw Hill, 2012.
4. Craig. J. J. “Introduction to Robotics- mechanics and control”, Addison- Wesley, 1999

Reference Books:

1. Peter D. Hilton, Hilton/Jacobs, Paul F. Jacobs, “Rapid Tooling: Technologies and Industrial Applications”, CRC Press, 2000.
2. Burns. M, “Automated fabrication”, Prentice-Hall, 1993.
3. Francis N. Nagy, Andras Siegler, "Engineering foundation of Robotics", Prentice Hall Inc., 1987.
4. P.A. Janaki Raman, "Robotics and Image Processing an Introduction", Tata McGraw Hill Publishing Company Ltd., 1995.

List of Experiment:

1. To study Robot configuration.
2. To identify the geometric relationship between input and output motion parameters of PUMA
3. 560 robot manipulator.
4. To study different types of end effectors with their section criteria and working.
5. To Study and selection of Gripper.
6. To Study of various Additive manufacturing Processes.
7. To Create a 3D Model of Keychain with your Name in any CAD Software.
8. To Convert CAD Model into printable file format.
9. To Analyze and optimize Data for Printing 3D Model by using PLA/ABS Material.

IPS Academy, Institute of Engineering & Science

(A UGC Autonomous Institute, Affiliated to RGPV, Bhopal)

Scheme & Syllabus

Mechanical Engineering Department

ME	Electric and Hybrid Vehicles	3L : 0T :2P (04 Hrs)	04 Credits

Prerequisite(s): Basic Mechanical Engineering and Basic Electrical & Electronic Engineering

Course Objective's:

To present a comprehensive overview of Electric and Hybrid Electric Vehicles

Course Content:

Module 1 **(10 hrs)**

Introduction: : Chassis & Body Engineering Technical details of commercial vehicles, types of chassis, layout, types of frames , Steering System front axle beam, stub axle, front wheel assembly, principles of types of wheel alignment, front wheel geometry viz. camber, Kingpin inclination, castor, toe-in and toe-out.

Transmission System: Function of clutches, single plate, multi-plate clutch, types of gear boxes, differential gear box, Suspension system : Basic suspension movements, Independent front & rear suspension, shock absorber

Module 2 **(8 hrs)**

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

Module 3 **(10 hrs)**

Hybrid Electric Drive-Trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Module 4 **(08 hrs)**

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices.

Module 5 **(08 hrs)**

Electric Propulsion Unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives

Course Outcome:

After completion of the course student will be able:

1. Understand the anatomy and functions of conventional vehicle system.
2. Understand importance of Hybrid & Electric Vehicles on environmental.
3. Develop basic concept of electric vehicles and hybrid electric vehicles drive train.
4. Choose proper energy storage systems for vehicle applications.
5. Develop basic concept of Configuration and control of DC Motor drive.

List of Text Books

1. 1.Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003
2. 2.Kripal Singh, Automotive Engineering Khanna Pub.

List of Reference Book

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003
3. Joseph Heitner, Automotive Mechanics, Principles and Practices, CBS Pub

List of Practical (Expandable)

1. Study of Steering, Gear Box, Suspension and Differential Mechanism.
2. Study of Electric vehicle drive train.
3. Study of Hybrid vehicle drive train.
4. Study of battery system & HV and LV line.
5. Study of cooling system in Electric & Hybrid vehicle.

IPS Academy, Institute of Engineering & Science

(A UGC Autonomous Institute, Affiliated to RGPV, Bhopal)

Scheme & Syllabus

Mechanical Engineering Department

ME	Introduction to Microfluidic Engg.	3L: 0T: 02P (04 Hrs)	04 Credits

Pre-requisite's: Basic Mechanical Engineering and Manufacturing Practices.

Course Objective's:

- To aware the students about the fundamental principles of fluid mechanics and microfluidics.

Course Content:

Module 1 **(08 Hrs)**

Introduction: fluid and the continuum, fluid properties, surface tension, bulk modulus and thermodynamic properties, Newton's laws of viscosity and it's coefficients, Newtonian and non Newtonian fluids, buoyancy, meta center and meta centric height.

Module 2 **(10 Hrs)**

Fluid Kinematics: Langragian and Eularian method, description of fluid flow, stream line, path line and streak line, types of flow and types of motion, local and connective acceleration, continuity equation, velocity potential, stream function.

Fluid Dynamics: Reynolds transport theorem, Euler's equation, Bernoulli's equation, momentum and moment of momentum equation, forces on immersed bodies, lift and drag.

Module 3 **(10 Hrs)**

Introduction to Microfluidics: Overview, Hydrodynamics, surface tension & applications, Scaling laws and effects in microfluidics, Low Re flows & examples, Liquid and particle handling in micro scale, Transports in micro scale, Opto-fluidics, Inertial-microfluidics, droplet-microfluidics, microfluidics based-flow cytometry.

Module 4 **(08 Hrs)**

Bio Detection and Analysis by Microfluidic Systems: Detection Principles Issues of mixing, Heat control and exchange, pH, on-chip pumping and flow control Types of Microarrays: DNA/RNA, Protein, Antibody, and Tissue microarrays

Module 5 **(10 Hrs)**

Active Microfluidics: Electrohydrodynamics, Electroosmosis, Dielectrophoresis and applications, Optofluidics, Acoustofluidics.

Microfabrications: Hard & Soft Lithography, Fabrication technique overview, Elements of microfluidic devices (micro-pump, mixers, lenses, valves, heaters, sensors, etc.,), utility of microfluidic devices in various biological, chemical and optical sensing applications.

Course Outcome:

After completion of the course student will be able:

1. Introduce the basic concepts of fluid.
2. Describe the motion of fluid and force applied to fluid in motion.
3. Gain a broad insight into microfluidics technology.
4. Apply microfluidics to biomedical engineering problems.
5. Use their knowledge design and model microfluidic systems.

Text Books:

1. A Textbook of Fluid Mechanics by R.K. Bansal, Laxmi Publication Ltd, 2008
2. Introduction to Fluid Mechanics and Fluid Machines by S. K. Som, 2002
3. Microfluidics and Microfabrication Chakraborty, Suman (Ed.) 2010.

Reference Books:

1. Fluid Mechanics and Fluid Machines by S.K Som,Gautam Biswas&Suman Chakraborty-
2. Fluid Mechanis by Yunus A. Cengel &John M. Cimbala
3. "An Introduction to Fluid Dynamics" by G. K. Batchelor, 1960's
4. Massy B.S., Mechanics of fluid, Routledge Publication.
5. Shames, Fluid Mechanics, Tata McGraw Hills.
6. Introduction to microfluidics by Patrick Tabeling, 2003
7. Microflows and Nanoflows: Fundamentals and Simulation, George Karniadakis, Ali Beşkök, Narayan Aluru, 2005, ISBN-10: 0-387-22197-2
8. Micro- and Nanoscale Fluid Mechanics: Transport in Microfluidic Devices, Brian J. Kirby, September 11, 2009.
9. Microfluidics and Lab-on-a-chip Book by Andreas Manz, Jonathan S O'Connor, and Pavel Neužil September, 2020.
10. Fundamentals and Applications of Microfluidics Book by Nam-Trung Nguyen and Steve Wereley, 2002.

List of Experiment:

1. Laminar Flow and Diffusion in a Microchannel.
2. Fabrication of a Glass Microfluidic Device.
3. A Simple Experiment for the Study of Droplet Microfluidics.
4. Determination of Electroosmotic Flow in a Glass Microfluidic Device Using a Neutral Marker.
5. Electrophoretic Separation in a Microchannel.
6. Fabrication and Testing of a PDMS Microchip.
7. Fabrication of a Paper Microfluidic Device for Blood-Plasma Separation.
8. Flow Synthesis of Organic Dye on Microchip.