IPS Academy, Institute of Engineering & Science
(A UGC Autonomous Institute, Affiliated to RGPV, Bhopal)
Scheme & Syllabus Based on AICTE Flexible Curricula **(B. Tech)**
Electronics & Communication Engineering Department

Bachelor of Technology (B.Tech.)
Minor Degree Certification Course in E Vehicle Engg.
(To be offered to students of other departments excluding ECE)

S. No.	Subject Code	Category	Semester	Subject Name	Contact Hours per week			Total Credits
					L	T	P	
1			V	Renewable Power Generation Technologies	2	1	2	4
2			VI	EV Batteries & Charging System	2	1	2	4
3			VII	Micro Electro Mechanical Systems	3	-	2	4
4			VIII	Electric & Hybrid Vehicles And Project	2	-	2	3
				Total	9	2	8	15

1 Hr Lecture	1 Hr Tutorial	2 Hr Practical
1 Credit	1 Credit	1 Credit

Note: *VII semester subject (Electric and Hybrid Vehicles and Project or any other course equivalent to Electric And Hybrid Vehicles And Project) can also be done from MOOC courses (NPTEL, SWAYAM, EDx etc.).

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	Renewable Power Generation Technologies	**2L: 1T: 2P (5 hrs.)**	**4 credits**

Course Objective:
The objective of the course is to understand the principle of working of different renewal energy sources.

MODULE 1 **(10 hrs.)**
Definition, Energy available from Sun, Solar radiation data, solar energy conversion into heat, Flat plate and Concentrating collectors, Principle of natural and forced convection. power generation. PV Systems - Design of PV systems-Standalone system with DC and AC loads with and without battery storage-Grid connected PV systems-Maximum Power Point Tracking

MODULE 2 **(10 hrs.)**
Wind energy – energy in the wind – aerodynamics - rotor types – forces developed by blades - Aerodynamic models – braking systems – tower - control and monitoring system - design considerations power curve - power speed characteristics-choice of electrical generators.

MODULE 3 **(10 hrs.)**
Fixed speed induction generator-performance analysis- semi variable speed induction generator variable speed induction generators with full and partial rated power converter topologies - isolated systems-self excited induction generator- permanent magnet alternator - performance analysis.

MODULE 4 **(08 hrs.)**
Definition and classification of resources, Utilization for electricity generation and direct heating, Wellhead power generating units. Basic features: Atmospheric exhaust and condensing, Exhaust types of conventional steam turbines. Pyrolysis of Biomass to produce solid, liquid and gaseousfuels. Biomass gasification, Constructional details of gasifier, Usage of biogas for chullas, various types of chullas for rural energy needs.

MODULE 5 **(08 hrs.)**
Wind- diesel system, wind - PV system, micro hydro-PV system, biomass - PV-diesel system, geothermal-tidal and OTEC systems.

Course Outcome:
Students earning credits will develop ability to:

1. Appraise the need and possibility of extracting solar energy and converting into electrical energy using PV cell.
2. Design and analyze stand-alone and grid connected PV system.
3. Describe the dynamics of wind turbine and electrical generator.
4. Select and design suitable configuration of the wind energy conversion system based on application.
5. Suggest, design and analyze hybrid energy systems.

List of Experiments:

1. Study of different power conversion techniques.
2. To study the solar energy to electricity conversion.
3. To study the Design of PV systems.
4. To study the deployment of forces by blade
5. To study the basic principal of induction motors.
6. To study the architecture of embedded system.
7. To study the architecture of 8051 microprocessor.
8. To study the different instructions sets used in 8051 microprocessor.
9. Write assembly language programming for 10 KHz square wave for 8051.
10. Write an assembly language programming for addition, subtraction, multiplications program.

Text/Reference Books:

1. Chetan Singh Solanki, 'Solar Photovoltaics -Fundamentals, Technologies and Applications', PHI Learning Pvt. Ltd., New Delhi, 2011
2. Van Overstraeton and Mertens R.P., 'Physics, Technology and use of Photovoltaics', Adam Hilger, Bristol, 1996.
3. John F., Walker & Jenkins. N, 'Wind energy Technology', John Wiley and sons, Chichester, UK, 1997.
4. Freries L. L., 'Wind Energy Conversion Systems', Prentice Hall, U.K., 1990

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	EV Batteries & Charging System	**2L: 1T: 2P (5 hrs.)**	**4 credits**

Course Objective:
This course provides a concise introduction to the batteries and their charging system.

MODULE 1 **(10 hrs.)**

Cell and battery voltages, Charge (or Amphour) capacity, Energy stored, Energy density, Specific power, Amphour (or charge) efficiency, Energy efficiency, Self-discharge rates, Battery geometry, Battery temperature, heating and cooling needs, Battery life and number of deep cycles

MODULE 2 **(06 hrs.)**
Lead Acid: Batteries Lead acid battery basics, Special characteristics of lead acid batteries, Battery life and maintenance, Battery charging, Summary. Nickel-based Batteries: Introduction, Nickel cadmium, Nickel metal hydride batteries

MODULE 3 **(10 hrs.)**
Sodium-based Batteries Introduction, Sodium sulphur batteries, Sodium metal chloride (Zebra) batteries Lithium Batteries Introduction, The lithium polymer battery, The lithium ion battery Metal Air Batteries Introduction, The aluminum air battery, The zinc air battery

MODULE 4 **(08 hrs.)**
Domestic Charging Infrastructure, Public Charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move-and-charge zone.

MODULE 5 **(06 hrs.)**
Battery Chargers: Charge equalization, Conductive (Basic charger circuits, Microprocessor based charger circuit. Arrangement of an off-board conductive charger, Standard power levels of conductive chargers, Inductive (Principle of inductive charging, Soft-switching power converter for inductive charging), Battery indication methods

Course Outcome:
Students earning credits will develop ability to:
1. Elaborate various technical parameters of batteries.
2. Distinguish between various types of batteries used for EV applications.
3. To develop battery charger for an EV.
4. Understand the different infrastructure of charging stations.
5. Understand the different type of battery charger mechanism.

Text/Reference Books:

1. James Larminie Oxford Brookes University, Oxford, UK John Lowry Acenti Designs Ltd., UK, Electric Vehicle Technology Explained
2. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001.

3. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
4. MehrdadEhsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
5. James Larminie, John Lowry, Electric Vehicle Technology Explained Wiley, 2003.

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	Micro Electro Mechanical Systems	**3L: 0T: 2P (4 hrs.)**	**4 credits**

Course Objective:
The course objective is to know the different sensors and electronic component used in e vehicle.

MODULE 1 **(06 hrs.)**
MEMS and Microsystems–MEMS as micro sensors and micro actuators- MEMS and Microsystem products– Evolution of Micro fabrication, Microsystems and Microelectronics Comparison of Microsystems and microelectronics-Multidisciplinary nature of Microsystems Microsystems and miniaturization- Applications of Microsystems in various industries.

MODULE 2 **(10 hrs.)**
Micro sensors- Bio sensors, Chemical sensors, Optical sensors, Pressure sensors, Thermal sensors – thermopiles, thermistors. Microactuator - Micro actuation principles-Micro gripper Micro motors-Micro valves-Micro pumps- Micro accelerometers-Micro fluidics0020

MODULE 3 **(10 hrs.)**
Substrates and wafers – Silicon as a substrate material, ideal substrates for MEMS – single crystal Silicon and wafers crystal structure – mechanical properties of Si –Silicon compounds – Gallium arsenide- quartz – piezoelectric crystals – polymers.

MODULE 4 **(08 hrs.)**
Photolithography-Ion Implantation-Diffusion-Chemical vapour deposition (CVD)-Enhanced CVD Physical vapors deposition (Sputtering)-Etching-chemical etching, plasma etching-Bulk Micro Machining -Surface Micro Machining -LIGA process.

MODULE 5 **(06 hrs.)**
General considerations in packaging - Levels of Microsystem packaging – die level, device level and system level – Essential packaging technologies – die preparation, surface bonding, wire bonding and sealing - Three-dimensional packaging, assembly of Microsystems – selection of packaging materials.

Course Outcomes:
Students earning credits will develop ability to:

1 Attain a broad range of the knowledge required to grow in the evolving field of MEMS and microsystem
2 Familiar with the principle and operation of microsensor and microactuator.
3 Select and assess suitable materials for manufacturing MEMS and microsystem.
4 Describe the different microfabrication and micromachining process.
5 Describe the different stages of microsystems packaging and packaging materials.

List of Experiments:
1. Write an assembly language programming for 10 KHz square wave.
2. To study the interfacing of LED with 8051
3. To study the interfacing of seven segment display with 8051

4. To study the interfacing of stepper DC motor with 8051
5. To study the basic principal of induction motors.
6. To study the serial and parallel communication protocols.
7. To study the different types of bio sensors.
8. To study the different types of optical and chemical sensors.
9. To study the architecture of MEMS and Microsystems.
10. To study the different Substrates and wafers techniques.

Text/Reference Books:

1 Tai-Ran Hsu, MEMS and Microsystems Design and Manufacture, Tata McGraw Hill, New Delhi, 2017.
2 Mahalik, N. P, MEMS, Tata McGraw Hill, New Delhi, 2007
3 Julian W. Gardner, Florin Udrea, Microsensors: Principles and Applications, Wiley, 2015.
4 Michael Kraft and Neil M. White, MEMS for automotive and aerospace applications, Woodhead Publishing Limited, 2013.
5 Chang Liu, "Foundations of MEMS", Pearson International Edition, 2006
6 Marc F Madou, Fundamentals of Micro Fabrication, CRC Press, 2nd Edition, 2002

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	Electric & Hybrid Vehicles And Project	**2L: 0T: 2P (4hrs.)**	**3 credits**

Course Objectives: To understand the electric and hybrid vehicle technology.

Course Contents (40 hrs.)

MODULE 1 **(06 hrs.)**

Past, Present & Feature of EV, Current Major Issues, Recent Development Trends, EV Concept, Key EV Technology, State-of-the Art EVs & HEVs, Comparison of EV Vs IC Engine. EV System: EV Configuration: Fixed & variable gearing, single & multiple motor drive, In-wheel drives EV Parameters: Weight, size, force, energy & performance parameters.

MODULE 2 **(10 hrs.)**

DC Motor: Type of wound-field DC Motor, Torque speed characteristics, DC-DC Converter, Two quadrant DC Chopper, two quadrant zero voltage transition converter-fed dc motor drive, speed control of DC Motor Induction Motor Drive: Three Phase Inverter Based Induction Motor Drive, Equal Area PWM, Three Phase Auxiliary resonant snubber (ARS) Inverter Type (ZVC & ZCS), Single Phase ARS Inverter Topology, Speed Control of Induction Motor, FOC, Adaptive Control, Model Reference Adaptive Control (MARS), Sliding mode Control.

MODULE 3 **(08 hrs.)**

HEV: Configuration of HEV (Series, Parallel, Series-parallel &Complex), Power Flow control, Examples. Power flow control in all HEV configurations, Examples of HEV system performance Energy Sources: Different Batteries, Battery characteristics (Discharging &Charging)

MODULE 4 **(08 hrs.)**

Battery Chargers: Conductive (Basic charger circuits, Microprocessor based charger circuit. Arrangement of an off-board conductive charger, Standard power levels of conductive chargers, Inductive (Principle of inductive charging, Soft-switching power converter for inductive charging), Battery indication methods.

MODULE 5 **(08 hrs.)**

Charging Infrastructure: Domestic Charging Infrastructure, Public Charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Moveand-chargezone.

Course Outcomes:

Students earning credits will develop ability to:

1 Design electric vehicle & HEV for various applications
2 Select appropriate motor and converter for EV applications

3 Select battery, battery indication system for EV applications
4 Design battery charger for an EV
6. Development of the Charging Infrastructure

Text/Reference Books:

1 C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001
2 Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
3 Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
4 James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.