Pimpri Chinchwad Education Trust's

PIMPRI CHINCHWAD COLLEGE OF ENGINEERING

SECTOR NO. 26, PRADHIKARAN, NIGDI, PUNE 411044

An Autonomous Institute Approved by AICTE and Affiliated to SPPU, Pune

DEPARTMENT OF ELECTRONICS AND TELECOMMUNICATION ENGINEERING

Curriculum Structure and Syllabus

of

Honor and Minor Courses in

B. Tech. Electronics and telecommunication Engineering

(Approved by BoS BOS- E&TC Engineering)

(Course 2020)

Effective from Academic Year 2021-22

Institute Vision

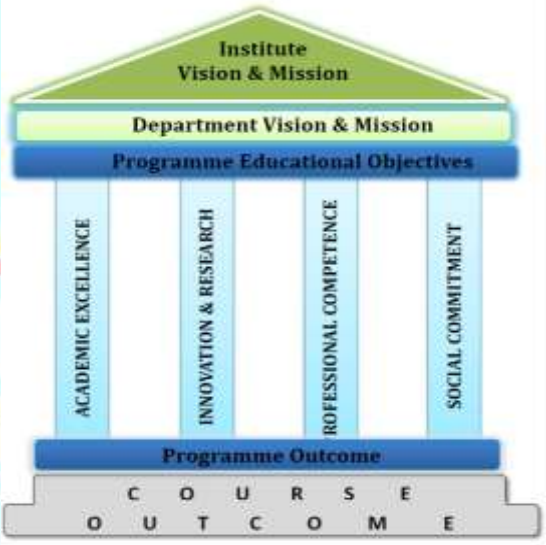
To Serve the Society, Industry and all the Stakeholders through the **Value-Added Quality Education.**

Institute Mission

To serve the needs of society at large by establishing State-of-the-Art Engineering, Management and Research Institute and impart attitude, knowledge and skills with quality education to develop individuals and teams with ability to think and analyze right values and self-reliance.

Quality Policy

We at PCCOE are committed to impart Value Added Quality Education to satisfy the applicable requirements, needs and expectations of the Students and Stakeholders. We shall strive for academic excellence, professional competence and social commitment in fine blend with innovation and research. We shall achieve this by establishing and strengthening state-of- the-art Engineering and Management Institute through continual improvement in effective implementation of Quality Management System.



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Honors in Data Informatics

Data Informatics

Data informatics is the **intersection of information science, computer science, and applied sciences.** This field deals with the resources, devices, and methods required to optimize the acquisition, storage, retrieval, and use of information in various application areas.

Features of data Informatics course for Engineers

This course helps to explore in following areas-

- Analyzing data to help facilitate decisions and actions of health , finance , military etc sector.
- Understanding issues related to collecting, storing and analyzing medical information in a digital format.
- Combining knowledge of several fields with engineering, informatics and communication systems.
- to gain an in-depth understanding of the data analysis and statists and to develop relevant programming skills

Curriculum structure

Sem-ester	Course Code	Course Name	Teaching Scheme					Evaluation Scheme						
			L	P	T	Hours	Credits	IE1	IE2	ETE	TW	PR	OR	Total
V	HET5981	Information Management Systems	4			4	4	20	30	50				100
	HET5982	Information Management Systems Lab		2		2	1				25		25	50
VI	HET6981	Internet of Medical Things	4			4	4	20	30	50				100
	HET6982	Internet of Medical Things Lab		2		2	1				25		25	50
VII	HET7981	Intelligent systems for healthcare	4			4	4	20	30	50				100
	HET7982	Seminar		4		4	2						50	50
VIII	HET8981	Project		8		8	4				100		50	150
Total			12	16		28	20							600

1 Lecture hour = 1 Credit 2 Lab Hours = 1 Credit 1 Tutorial Hour = 1 Credit
Abbreviations are: L-Lecture, P-Practical, T-Tutorial, H- Hours, IE- Internal Evaluation, MTE- Mid Term Evaluation, ETE- End Term Evaluation, TW –Termwork, OR – Oral

Objectives:

1. Explain the subject health informatics as an academic discipline and its practical application in health care
2. Introduce students to problems and challenges that health informatics addresses
3. Introduce students to the research and practice of health informatics
4. Provide all students with basic skills and knowledge in health informatics to apply in their future health-related career.
5. Lead students in discussion around ethical and diversity issues in health informatics
6. Provide additional direction to those interested in further (i.e., graduate) study in the field

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

1. Explore how technology can be used to improve health care delivery in health care organizations and in public health.
2. Acquire breadth of knowledge of the principles of health informatics.
3. Develop basic skills in using health informatics principles to improve practice.
4. Acquire a conceptual and theoretical framework of the design, development, and implementation of health information systems.
5. Acquire a basic understanding of educational and instructional design theory and principles and how the principles can be applied to deliver effective training to users of health information systems.

Course Syllabus

Program:	B. Tech. (E&TC-Honors)			Semester:	VI		
Course:	Information Management System			Code:	HET5981		
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	IE1	IE2	ETE	Total
4	-	-	4	20	30	50	100

Prior Knowledge of: Medical data collection and processing **is essential.**

Course Objectives:

1. To introduce the collection, analysis and management of health Information management system
2. To cover need and requirement of different informatics skills
3. To introduce the detail about Electronics medical record.
4. To introduce the concept of designing and evaluation of methodology of information system
5. To explore the security aspect of health management data
6. To introduce the standards and norms related with Information management

Course Outcomes: After learning the course, the students should be able to:

1. Understand the different data manipulation and collection
2. Apply the informatics skill for further research.
3. Analyze the characteristics of the Electronic Health Record (EHR) as a component of a comprehensive Health Information Systems (HIS).
4. To understand the Quality norms and Data security

Detailed Syllabus:

Unit	Description	Duration
1.	**Introduction to Health Information management System:** Information and management model, Collect and maintain health data (such as data elements, data sets, and databases). Conduct analysis, documentation in the health record, supports the diagnosis and reflects the patient's progress, clinical findings, and discharge status. Policies and procedures, accuracy of health data. Verify timeliness, completeness, accuracy, and appropriate	7
2.	**Informatics Skills:** Formal and Informal information System Communicating, Structuring, Questioning, Searching, Problem-solving skills, Knowledge of health data systems, Programming knowledge	6
3.	**Electronic medical record:** Overview of the Electronic Health Record (EHR) Clinical Workflow, Coding Systems, Data Capture & Functional Benefits (Data Entry at the Point of Care, Electronic Orders, Longitudinal Patient Records, Problem List, Flow Sheets, & Anatomical Drawings. Using the EHR to Improve Patient Health	7
4.	**Designing and evaluation of Information System:** software development processes, in particular, the systems development life cycle (SDLC). Variations on standard design methodologies	5
5.	**Data Security:** Apply confidentiality and security measures to protect electronic health information. Protect data integrity and validity using software or hardware technology. Apply departmental and organizational data and information system security policies. Use and summarize data compiled from audit trails and data quality monitoring programs	6
6.	**Quality assurance and management:** Concepts of Quality of Care , Quality Improvement Approaches ,Standards and Norms , Quality Improvement Tools , Introduction to NABH guidelines	5
	Total	36

Text Books:

1. Enrico Coiera, Guide to Health Informatics (Arnold Publication) (2003)
2. ArjunPanesar, Machine Learning and AI for Healthcare. Big Data for improved Health Outcomes (2019)
3. Arun Kumar Sangaiah, S.P. Shantharajah, et al., Intelligent Pervasive Computing Systems for Smarter Healthcare (2019)

Reference Books:

1. AthinaLazakidou, Handbook of Research on Informatics in Healthcare And Biomedicine (2006)
2. ArisGkoulalas-Divanis, GrigoriosLoukides, Anonymization of Electronic Medical Records to Support Clinical Analysis (2013)
3. Khalil Khoumbati, Yogesh Kumar Dwivedi, et al., Handbook of Research on Advances in Health Informatics and Electronic Healthcare Applications - Global Adoption and Impact of Information Communication.

Program: B. Tech. (E&TC-Honors)					**Semester : V**		
Course : Information Management Systems Lab					**Code :HET5982**		
Teaching Scheme				**Evaluation Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**TW**	**OR**	**PR**	**Total**
--	02	--	01	25	25	--	50

Prior knowledge of:

1. Medical data collection and processing
2. Programming using 'C' **is essential**

Objectives:

1. To explain need of health information management system in clinical research
2. To discuss methods of Electronics health record management and maintenance.
3. To explore role of security and confidentiality in Health information management.

Outcomes: At the end of Laboratory work, the students will be able to:

1. Design Complex information management system for medical applications.
2. Design clinical records for research and history maintenance.
3. Develop GUI based application on android for securely storing health information.
4. Develop information web-based storage and retrieval system.

General Guidelines: Any Eight Experiments is to be performed.

Detailed Syllabus:

Expt. No.	**List of Experiments**
1	Design and Implement Information management System for complex health data analysis using SQTL
2	Design and Implement Information management System for clinical Finding records or Electronics Health Records
3	Design and Implement GUI based Information coding system and security credential
4	Develop Website for collecting information of Blood Bank.
5	Develop Website for statistical information searching for health diseases.

Reference Books:

1. Arshdeep Bahga, Vijay Madisetti, "internet of Things – A hands-on approach", Universities Press, 2015
2. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols", Wiley, 2012.
3. Jan Ho" ller, VlasiosTsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence", Elsevier, 2014.
4. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.
5. Michael Margolis, Arduino Cookbook, "Recipes to Begin, Expand, and Enhance Your Projects", OReilly Media, 2nd Edition.

Program:	B. Tech. (E&TC-Honors)			Semester:	VI		
Course:	Internet of Medical Things (IoMT)			Code:	HET6981		
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	IE1	IE2	ETE	Total
4	-	-	4	20	30	50	100

Prior Knowledge of:

1. Basic communication systems and Basics **IoT** **Is essential**

Course Objectives:

1. Describe the basic concepts of IOT in healthcare
2. Explain existing hardware platforms and sensor interfaces for various healthcare based Applications
3. Describe he ways of communication between the client and the server in IOT
4. Explain applications in healthcare using IOT based approach and substantiate the same with appropriate case studies

Course Outcomes: After completion of this course Students should be able to :

1. Understand Role of IoT in health care sector
2. Gain knowledge about Various protocols in IoMT
3. Analyze the communication system requirements of IOT in health care
4. Understanding Internet and economics of internet in Health care system
5. Analyzing Case studies of IoT in health care.
6. Gain knowledge of wearable devices.

Detailed Syllabus:

Unit	Description	Duration
1.	**Internet of Things (IOT):** An Introduction Introduction to Embedded Systems-an overview, features. Networked Embedded System types and overview, wireless communication standards-zigbee, Bluetooth & Wi-Fi. OSI & TCP/IP model in a nutshell. Introduction to the Internet and understand how internet works. Introduction to Smart Objects or Things. IOT- understand what IOT is and discuss its application in health-care systems- Patient Monitoring & diagnostics, Home healthcare & Personal care & Fitness.	**8**
2.	**Protocol based systems:** Structure of protocols and protocols life cycles, application of protocols , passive and active protocols systems, protocols representations and language, Design of protocols ,construction and maintenance.	**4**
3.	**Communication system in Healthcare:** Communication system basics, Information transaction in health care, machine communication on set of layered protocols, wireless and wireline communication, clinical communication and telemedicine.	**4**
4.	**The Internet and web health services:** Evolution of internet as a tool to support health systems, communication on internet, Web health services, online systems for decision making, Security on internet, Information economics on internet.	**6**
5	Applications of Iot in Medicine Healthcare Monitoring system through Cyber-physical system, An loT Model for Neuro sensors, AdaBoost with feature selection using loT for somatic mutations evaluation in Cancer, Secured architecture for loT enabled Personalized Healthcare Systems, Healthcare Application Development in Mobile and Cloud Environments, Case study : Approach to predict Diabetic Retinopathy through data analytics, Diagnosis of chest diseases using artificial neural networks	**8**
6	**Wearable devise in IOMT:** Overview on Wearable Devices for Medical Applications: Wearable/Implantable Devices for Monitoring Systems. Wearable Sensors for Monitoring Exercise and Fatigue Estimation in Rehabilitation.	**6**
	Total	36

Text Books:

1. Guide to healthcare informatics , 2nd Edition, Arnold Publication, EnriocoCoira 2019
2. ABC of Health Informatics , ABC series by Frank Sullivan, Jyreme C Watt , 2006

Reference Books:

1. ArshdeepBahga, Vijay Madisetti, “lnternet of Things – A hands-on approach”, Universities Press, 2015
2. Olivier Hersent, David Boswarthick, Omar Elloumi , “The Internet of Things – Key applications and Protocols”, Wiley, 2012.
3. Jan Ho” ller, VlasiosTsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, “From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence”, Elsevier, 2014.
4. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer, 2011.
5. Michael Margolis, Arduino Cookbook, “Recipes to Begin, Expand, and Enhance Your Projects”, OReilly Media, 2nd Edition.

Program: B. Tech. (E&TC-Honors)					Semester : VI		
Course : Internet of Medical Things Lab					Code :HET6982		
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	TW	OR	PR	Total
--	02	--	01	25	25	--	50

Prior knowledge of:

1. Programming languages 'C'and SQL
2. Statistical methods of data handling

is essential

Objectives:

4. To deliver practical knowledge of Medical data processing and management.
5. To explain application communication methods for medical applications.
6. To explore Internet of Medical Things (IoMT)

Outcomes:

At the end of Laboratory work, the students will be able to:

5. Select appropriate communication coding method for medical information handling.
6. Understand concepts of clinical communication and telemedicine.
7. Design Wearable Devices for Medical Applications.

Detailed Syllabus:

Expt. No.	List of Experiments
1	Design and implement READ codes for ECG data handling using 'C'
2	Create and establish SNOMED protocol for lung diseases using SQL
3	Design and implement Heart Patient Monitoring system using IoT Platform
4	Design IoT environment for remote patient monitoring.
5	Design Qualitative and Quantitative based prediction model for disease detection.

Reference Books:

1. ArshdeepBahga, Vijay Madisetti, "lnternet of Things – A hands-on approach", Universities Press, 2015
2. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols", Wiley, 2012.
3. Jan Ho" ller, VlasiosTsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence", Elsevier, 2014.
4. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.
5. Michael Margolis, Arduino Cookbook, "Recipes to Begin, Expand, and Enhance Your Projects", OReilly Media, 2nd Edition.

Program:	B. Tech. (E&TC-Honors)					Semester:	VII /VIII
Course:	Intelligent Systems for Healthcare					Code:	HET7981
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	IE1	IE2	ETE	Total
4	-	-	4	20	30	50	100

Prior Knowledge of: Medical data collection and processing **is essential.**

Course Objectives:

1. To explore technological challenges in healthcare and medical information handling
2. To cover significance of machine learning and artificial intelligence in ehealth management systems.
3. To introduce new technology in health monitoring such as Telemedicine, bio-surveillance, bioinformatics.

Course Outcomes: After learning the course, the students should be able to:

1. Understand existing healthcare and intelligent systems.
2. Apply machine learning and AI models for healthcare monitoring and analysis.
3. Design Intelligent Pervasive Computing Systems for Smarter Healthcare.
4. Analyze knowledge management system in ehealth, medicine and telemedicine
5. Understand importance of Bio-surveillance and bioinformatics
6. Analyse the performance of designed system for various health related applications.

Detailed Syllabus:

Unit	Description	Duration
1.	**Introduction to Healthcare and Intelligent System:** Overview of Health Care Systems and Key Challenges, Case Study on Electronic Medical Records Data, Clinical decision support systems, Intelligent systems, Rule-based expert systems, Model-based systems, Machine learning systems for new clinical knowledge, , Automated interpretation, level of Interpretation, Intelligent Monitoring Systems, types of errors due to automations.	6
2.	**Machine Learning and AI for Healthcare:** Machine Learning Approach in healthcare, Role of Artificial Intelligence, Applications of AI in Healthcare, Healthcare Data—Little and Big Use Cases, Realizing the Potential of AI in Healthcare, Evaluating Learning for Intelligence, Ethics of Artificial Intelligence and Machine Learning, Health Intelligence , Future of Healthcare, Evidence-Based Medicine, Connected Medicine, Medication Adherence, Smart Implantable.	7
3.	**Intelligent Pervasive Computing Systems for Smarter Healthcare:** Intelligent Sensing and Ubiquitous Systems (ISUS) for Smarter and Safer Home Healthcare, PeMo-EC: An Intelligent, Pervasive and Mobile Platform for ECG Signal Acquisition, Processing, and Pre-Diagnostic Extraction, The Impact of Implantable Sensors in Biomedical Technology on the Future of Healthcare Systems, IoT-Based Noninvasive Wearable and Remote Intelligent Pervasive Healthcare Monitoring Systems for the Elderly People	7
4.	**TELEMEDICINE AND E-HEALTH:** Knowledge Management in Telemedicine, Telemedicine Systems and Devices for Patient Monitoring, Telehealth Applications in Telemedicine, Mobile Tele-monitoring Insights, Tele-pathology and Digital Pathology, Goals and Benefits of Knowledge Management in Healthcare	5
5.	**Bio-surveillance:** Event reporting, Infectious disease surveillance systems, Online evidence retrieval, communication technologies to support bio-surveillance, Bioinformatics: concept of Bioinformatics, Genome science and data, Applications of Bioinformatics.	5
6.	**Case Studies:** Secure Pervasive Healthcare System and Diabetes Prediction Using Heuristic Algorithm, Threshold-Based Energy-Efficient Routing Protocol for Critical Data Transmission to Increase Lifetime in Heterogeneous Wireless Body Area Sensor Network, Data Mining Techniques for the Detection of the Risk in Cardiovascular Diseases, Smart Sensing System for Cardio Pulmonary Sound Signals.	6
	Total	36

Text Books:

1. Enrico Coiera, Guide to Health Informatics (Arnold Publication) (2003)
2. Arjun Panesar, Machine Learning and AI for Healthcare. Big Data for improved Health Outcomes (2019)
3. Arun Kumar Sangaiah, S.P. Shantharajah, et al., Intelligent Pervasive Computing Systems for Smarter Healthcare (2019)

Reference Books:

1. Athina Lazakidou, Handbook of Research on Informatics in Healthcare And Biomedicine (2006)
2. Aris Gkoulalas-Divanis, Grigorios Loukides, Anonymization of Electronic Medical Records to Support Clinical Analysis (2013)
3. Khalil Khoumbati, Yogesh Kumar Dwivedi, et al., Handbook of Research on Advances in Health Informatics and Electronic Healthcare Applications - Global Adoption and Impact of Information Communication.

Program:	**B. Tech. (E&TC-Honors)**				**Semester:**	**VII /VIII**
Course:	**Seminar**				**Code:**	HET7982
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Practical**	**Credit**	**IE2**	**TW**	**OR**	**Total**
-	**4**	2			50	50

Prior Knowledge of: -- is essential.

Course Objectives:

1. To identify practical learning skills and concepts and learn to communicate it to society.
2. To encourage personal growth of students and development of effective communication skills

Course Outcomes: After learning the course, the students should be able to:

1. Get an overview of the current trends and Learn them in more details
2. Improve Practice written and oral presentations
3. Learn the research methods used in that specific field

Detailed Guidelines:

1. The student should let the course instructor know in advance the intended topic of the seminar.
2. The length of the seminar should be at most 30 minutes, including time at the end for questions from the audience.
3. Each seminar should be given by one single student.
4. The intended audience for the seminar are other students attending the course. Prepare the seminar accordingly.
5. The focus should be on main ideas rather than on technical details
6. The seminar guidelines mentioned in B.Tech (E&TC) structure will be followed for evaluation of performance and certification compliance.

Program:	B. Tech. (E&TC-Honors)			Semester:	VII /VIII
Course:	Project			Code:	HET8981
Teaching Scheme			Evaluation Scheme		
Lecture	Practical	Credit	IE2	TW	OR	Total
-	8	4	-	100	50	150

Prior Knowledge of: Information management, Machine Learning and IoT **is essential.**

Course Objectives:

1. To test students' knowledge of course implementation.
2. To make students ready for data analytics-oriented design and analysis.

Course Outcomes: After learning the course, the students should be able to:

1. Solve real time problems observed in industry.
2. Deal with data handling, management and analysis of real time application.

Detailed Guidelines:

1. The students are encouraging to take projects for developing software solutions and hardware platforms using the concept of course taken under the certification.
2. Project should be individual and preferably form Industry.
2. The project guidelines mentioned in B.Tech (E&TC) structure will be followed for evaluation of performance and certification compliance.

Mooc Courses : For Reference

1.	Bioinformatics & Health Informatics Course era courses
2.	AI in Healthcare Coursera (https://www.coursera.org/specializations/ai-healthcare)
3.	Records and Health Information Management (Udemy Paid -490) https://www.udemy.com/course/records-and-health-information-management/
4.	Introduction to Hospital Information Systems(Udemy Paid -490)

Honors in Electric Vehicle technology

Electric Vehicle technology

Adopting e-mobility does not only change the way we approach the road but also improves the quality of our lives. The emergence of electric vehicles in recent years introduced a new viable mode of transportation. As a result, the e-mobility ecosystem has become the pillar of the economy, providing millions of jobs worldwide.

Features of Electric vehicle technology course for Electronics Engineers

This course helps to explore in following areas-

- Components of the Electric vehicles
- Complexity requirements of Electric vehicles technology
- State-of-the-Art: analysis of existing Electric vehicles architecture models
- Various aspects of Electric Vehicles, understand Mobility and its evolutions.

Curriculum structure

Semester	Course Code	Course Name	Teaching Scheme					Evaluation Scheme						
			L	P	T	Hours	Credits	IE1	IE2	ETE	TW	PR	OR	Total
V	HET5984	Energy storage system for electric Vehicles	4	-	-	4	4	20	30	50				100
	HET5985	Energy storage system for electric Vehicles Lab		2		2	1				25		25	50
VI	HET6984	EV motor drives and controllers for Electric Vehicles	4	-	-	4	4	20	30	50				100
	HET6985	EV motor drives and controllers for Electric Vehicles lab		2		2	1				25		25	50
VII	HET7984	EV system design and architecture	4			4	4	20	30	50				100
	HET7985	Seminar		4		4	2						50	50
VIII	HET8982	Project		8		8	4				100		50	150
Total			**12**	**16**		**28**	**20**							**600**

1 Lecture hour = 1 Credit 2 Lab Hours = 1 Credit 1 Tutorial Hour = 1 Credit

Abbreviations are: L-Lecture, P-Practical, T-Tutorial, H- Hours, IE- Internal Evaluation, MTE- Mid Term Evaluation, ETE- End Term Evaluation, TW –Termwork, OR – Oral

Objectives:

1. To explain the basics of electric vehicle system, their design methodologies, architecture and fundamentals.
2. To analyze various electric motor drives suitable for electric vehicles.
3. To emphasize on the various power electronics devices suitable for electric vehicles.
4. To discuss different energy storage systems used for electric vehicles and their management.
5. To demonstrate different configurations of electric vehicles and its components, sizing of components, design optimization and energy management.
6. To introduce the fundamentals of batteries, Charging and Swapping infrastructure in e-Mobility era.

Outcomes: Students will be able to:

1. Explain the basics of electric vehicles, their design methodologies, architecture and fundamentals.
2. Analyze the use of different electric motor drives in electric vehicles.
3. Analyze the use and suitability of various power electronics devices for electric vehicles.
4. Explain the use of different energy storage devices used for electric vehicles, their technologies and control and select appropriate technology
5. Interpret working of different configurations of electric vehicles and its components, performance analysis and Energy Management strategies in EVs.
6. Appreciate the importance of battery swapping technology in e-mobility domain.

Course Syllabus

Program:	**B. Tech. (E&TC-Honors)**			**Semester:**	**V**		
Course:	Energy storage system for electric Vehicles			**Code:**	HET5984		
Teaching Scheme				**Evaluation Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
4			4	20	30	50	100

Prior Knowledge of:

2. General background on alternative energy sources and sustainability

3. Electric vehicles configuration

Is essential

Course Objectives:

1. To learn fundamentals of energy storage systems for Electric vehicles
2. To understand advanced batteries, supercapacitors, and fuel cells for Electric Vehicles
3. To discuss the Hybridization of various energy storage systems such as battery– supercapacitors, Battery–fuel cell, and battery–supercapacitor–fuel cell
4. To provide the fundamentals of battery management systems.

Course Outcomes:

Students will be able to

1. Utilize the fundamentals of advanced batteries, supercapacitors and fuel cells for Electric vehicles application

2. Apply the knowledge of hybridization of various energy conversion devices for vehicle electrification
3. Understand battery management systems and state-of-charge estimation
4. Realize the battery testing procedures and verification of battery performances.

Detailed Syllabus:

Unit	**Description**	**Duration**
1.	**Energy Storage:** Introduction to Energy Storage Requirements in Electric Vehicles. Battery, Fuel Cell, Super Capacitor and Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.	**6**
2.	**Energy Storage Systems:** Batteries - Advanced Lithium Batteries and Beyond lithium batteries, Lead-acid battery, High temperature batteries for back-up applications, Double layer and Supercapacitors for e-mobility application, Fuel Cells and Hydrogen Storage	**6**
3.	**Battery Chargers and Battery Testing Procedures:** Constant current and constant voltage methods Hybrid methods Inductive chargers Battery power testing for various vehicles Battery testing for urban and highway driving cycles	**6**
4.	**Battery Management Systems (BMS):** Fundamentals of battery management systems and controls	**6**
5.	**Battery Recycling Technologies:** Technology and economic aspects of battery recycling Battery Applications for Stationary and Secondary Use	**6**
6.	**Electric Vehicles charging station:** Type of Charging station, Selection and Sizing of charging station, Components of charging station	**6**
	Total	36

Text Books:

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003
2. D. A. J. Rand, R. Woods, and R. M. Dell, “Batteries for Electric Vehicles,” Society of Automotive Engineers,” Warrendale PA, 2003.
3. Energy Storage by Robert A. Huggins, Springer Publication
4. Energy Management Handbook, Wayne C. Turner, The Fairmont Press Inc., 5th Edition, Georgia.

Reference Books:

1. G-A. Nazri and G. Pistoa, Lithium Batteries, Science and Technology, Kluwer Academic Publisher, 2003.
2. H. A. Kiehne, “Battery Technology Handbook,” Marcel Dekker, NYC, 2003.
3. James Larminie and John Lowry, “Electric Vehicle Technology Explained,” John Wiley, 2003.
4. D. Linden and T. S. Reddy, “Handbook of Batteries,” 3rd Edition, McGraw-Hill, 2002.

5. Energy storage (A new approach) by Ralph Zito Wiley Publication

Program: B. Tech. (E&TC-Honors)	**Semester : V**
Course : Energy storage system for electric Vehicles	**Code :** HET5985

Teaching Scheme				**Evaluation Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**TW**	**OR**	**PR**	**Total**
--	02	--	01	25	25	--	50

Prior knowledge of: Electronic Devices is essential

Objectives:

1. Develop the student's simulation skill in energy storage device modeling.
2. Analyze parameter for energy storage device.
3. Understand the charging and discharging process of energy storage device.

Outcomes: At the end of Laboratory work, the students will be able to:

1. Analyze charging techniques of energy storage device for Electric Vehicle.
2. Understand the testing procedure of battery.
3. Illustrate the role of C-rate in charging/discharging a battery.

General Guidelines: Any Eight Experiments is to be performed.

Detailed Syllabus:

Expt. No.	**List of Experiments**
1	Study the basic parameters of battery
2	Measure the charging voltage and current of given battery.
3	Demonstrate any charging technique of lead acid battery/ Lithium Ion battery.
4	Demonstrate the discharging process of battery using various values of C-rate and compare it.
5	Simulate battery model of given battery using any simulation tool.
6	Simulation on charging techniques of battery.
7	Study the process of battery testing and measure the parameters of battery.
8	Study and Demonstration of Battery Temperature Measurement (Thermocouple, Thermistor etc)
9	Battery pack design for given EV application (Testing Various series parallel combinations for given application)
10	Case Study: Design, selection, sizing and components of any developed charging station for EV.
11	Visit to any industry/ Research laboratory related to battery and EV.

Reference Books:

1. D. Linden and T. S. Reddy, "Handbook of Batteries," 3rd Edition, McGraw-Hill, 2002.
2. D. A. J. Rand, R. Woods, and R. M. Dell, "Batteries for Electric Vehicles," Society of Automotive Engineers," Warrendale PA , 2003.
3. M. Westbrook, "The Electric and Hybrid Electric Car," Society of Automotive Engineers," Warrendale PA , 2001.
4. MATLAB Simulink Tool

Program:	**B. Tech. (E&TC-Honors)**				**Semester:**	**VI**	
Course:	EV motor drives and controllers for Electric Vehicles				**Code:**	HET6984	
Teaching Scheme				**Evaluation Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
4			4	20	30	50	100

Prior Knowledge of: Basics of DC machines, Basics of Electrical Engineering

Course Objectives:

1. To understand the basics and requirements of motors and controllers for EV.
2. To understand suitability of electric motor & their control
3. To understand speed control of Induction motor
4. To learn fundamentals of BLDC motor
5. To understand PWM techniques of Inverter for Induction motor
6. To understand about Electric vehicle drives and control

Course Outcomes: Students will be able to

1. Analyze the requirements of EV motors
2. Evaluate the suitability of electric motor & their control for EV
3. Apply the knowledge of speed control of Induction motor for EV design
4. Illustrate the characteristics of BLDC motor for EV application
5. Apply the PWM techniques of Inverter for Induction motor
6. Comprehend the Configurations and Performance of Electric vehicles, their drives and control.

Detailed Syllabus:

Unit	**Description**	**Duration**
1.	**EV Motors Characteristics and DC motor:** Requirement of EV motors, Comparison of EV motors, Basics of DC Motor, Torque speed characteristics, DC Motor dynamics, Field Weakening Control, Four quadrant operation	**4**
2.	**DC Motor Dynamics & Control:** Current Loop Control, Speed Control Loop Dynamical System Control: Gain & Phase Margins, PD Controller, PI Controller, Selecting PI Gain for Speed Controller, PI Controller Design, PI Controller with Reference model, Comparison of conventional PI Controller with PI controller with Reference Model,DOF Controller with Internal Model Control, Load Torque Observer, Feedback Linearization, Simplified Modeling of Practical Current Loop	**8**
3.	**Induction Motor and speed control:** Rotating Magnetic Field, Basics of Induction motor, Speed-Torque Curve Leakage inductance, circle diagram, current displacement (double cage rotor), line starting, Dynamic modelling of Induction motor, Rotor Field oriented control, Stator Field Oriented Control, Field Weakening Control, Variable Voltage Variable Frequency Control	**7**
4.	**Permanent Magnetic Brush-Less DC motor Drives:** Basic principles of BLDC Motor Drives, BLDC Machine construction, Classification properties of PM material, Alnico, Ferrites, Rare-Earth PMs	**5**
5.	**PWM and Inverter:** Sinusoidal PWM, Injection of third order harmonics, Space Vector Modulation, Dead time & compensation, Encoders, Resolvers, R/D Converters, Hall current sensors and current sampling, Voltage Model Estimator, Current Model Estimator, Closed-loop MRAS observer, Sliding Mode Observer.	**6**
6.	**Electric Vehicle drives:** Configurations of electric vehicles, Performance of Electric vehicles, Traction motor characteristics, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Energy consumption	**6**
	Total	**36**

Text Books:

1. K Wang Hee Nam: AC Motor Control & Electrical Vehicle Application, CR Press, Taylor & Francis Group, 2019
2 C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001

Reference Books:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

Program: B. Tech. (E&TC-Honors)							**Semester : VI**
Course : EV motor drives and controllers for Electric Vehicles							**Code :** HET6985
Teaching Scheme				**Evaluation Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**TW**	**OR**	**PR**	**Total**
--	02	--	01	25	25	--	50

Prior knowledge of: Electric circuits is essential

Objectives:

1. To develop Student's simulation skills in Electric drives and controller
2. To analyse important parameters for Electric drives and controller

General Guidelines: Any Eight Experiments is to be performed.

Detailed Syllabus:

Expt. No.	**List of Experiments**
1	Demonstration of Wiring layout of Electric Vehicles
2	Current/Voltage control of Electric Vehicles
3	Control Circuit of Induction motor
4	Demonstration of controller s and actuators in Electric vehicles
5	V/f control of three phase induction motor
6	Speed control of BLDC motor in two-wheeler
7	Speed control of SRM motor in three wheeler
8	Simulation of Four quadrant operation of three phase induction motor
9	MOSFET based Step up and step down chopper
10	VI characteristics of SCR, IGBT and MOSFER
11	Three phase IGBT based PWM inverter control of Induction motor

Reference Books:

1. MATLAB Simulink examples
2. Power Electronics: Circuits, Devices and Applications- M.H Rashid, Pearson Education, PHI 3rd Edition, New Delhi 2004

Program:	**B. Tech. (E&TC-Honors)**				**Semester:**	**VII**	
Course:	EV system design and architecture				**Code:**	HET7984	
Teaching Scheme				**Evaluation Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
4			4	20	30	50	100

Prior Knowledge of:
Basic Electrical principle and electrical technology Is essential

Course Objectives:
1. To learn the basics of Electric vehicles and its classification
2. To understand the Configurations, Performance and architecture of EV
3. To learn the Modelling and design of Electric vehicles as a system
4. To understand electric components used in electric vehicles and their details.
5. To learn the Energy Storage Systems and energy management strategies for EVs

Course Outcomes:
Students will be able to
1. Compare Electric Vehicle against the Internal combustion Engine.
2. Discuss Electric and Plug-in Electric Vehicle and their performance.
3. Model and design EVs as a system
4. Explain the complete Electric Propulsion unit of Electric vehicles
5. Relate the Energy Storage Systems and energy management strategies for EVs

Detailed Syllabus:

Unit	**Description**	**Duration**
1.	**Introduction to Electric Vehicles:** Components of Electric Vehicle, Comparison with Internal combustion Engine: Technology, Benefits and Challenges, EV classification and their electrification levels.	**6**
2.	**Electric and Plug-in Electric Vehicle:** Configurations of Electric Vehicles (EV), Performance of EV, Architectures of EV, Vehicle batteries and its modelling, Battery operated EV, Plug-in EV	**6**
3.	**Controls Modelling and Design for EV:** System and sub-systems, Modelling and design of EVs as a system, principles of controls engineering for EV.	**6**
4.	**Electric Propulsion unit:** Introduction to electric components used in electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive efficiency.	**6**
5.	**Energy Storage Systems:** Energy storage systems used; Battery electro-chemistry, battery design and construction, charging and discharging, power density, Battery interface with motive sources	**6**
6.	**Energy Management Strategies:** Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.	**6**
	Total	36

Text Books:
1. Iqbal Husain, "Electric and Hybrid Vehicles –Design Fundamentals", CRC Press
2. L. Guzzella and A. Sciarretta, Vehicle Propulsion Systems: Introduction to modeling and Optimization, Springer 2007, Third Edition

Reference Books:
1. Mehrdad Ehsani, Yimin Gao, Sebastian E.Gsay, Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell vehicles-Fundamentals - Theory and Design", CRC Press
2. "Bosch' Automotive Handbook", 8th Edition

Program:	**B. Tech. (E&TC-Honors)**				**Semester:**	**VII /VIII**
Course:	**Seminar**				**Code:**	HET7985
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Practical**	**Credit**	**IE2**	**TW**	**OR**	**Total**
-	**4**	2			50	50

Prior Knowledge of: -- is essential.

Course Objectives:

1. To identify practical learning skills and concepts and learn to communicate it to society.
2. To encourage personal growth of students and development of effective communication skills

Course Outcomes: After learning the course, the students should be able to:

1. Get an overview of the current trends and Learn them in more details
2. Improve Practice written and oral presentations
3. Learn the research methods used in that specific field

Detailed Guidelines:

1. The student should let the course instructor know in advance the intended topic of the seminar.
2. The length of the seminar should be at most 30 minutes, including time at the end for questions from the audience.
3. Each seminar should be given by one single student.
4. The intended audience for the seminar are other students attending the course. Prepare the seminar accordingly.
5. The focus should be on main ideas rather than on technical details
6. The seminar guidelines mentioned in B.Tech (E&TC) structure will be followed for evaluation of performance and certification compliance.

Program:	**B. Tech. (E&TC-Honors)**			**Semester:**	**VII /VIII**
Course:	**Project**			**Code:**	HET8984
Teaching Scheme			**Evaluation Scheme**		
Lecture	**Practical**	**Credit**	**IE2**	**TW**	**OR**	**Total**
-	**8**	4		100	50	150
Prior Knowledge of: basic electric technology and motors is essential.						
Course Objectives: 1. To test students' knowledge of course implementation. 2. To make students ready for EV design and analysis.						
Course Outcomes: After learning the course, the students should be able to: 1. Solve real time problems observed in industry. 2. Deal with EV technology, updates, management and analysis motors and drives.						
Detailed Guidelines: 1. The students are encouraging to take projects for developing software solutions and hardware platforms using the concept of course taken under the certification. 2. The project guidelines mentioned in B.Tech (E&TC) structure will be followed for evaluation of performance and certification compliance.						

Minor In Robotics

Robotics

The robotics minor covers **the fundamentals of designing, building and programming robots**, and provides a concentrated experience in the multidisciplinary field of robotics.

This course helps to explore in following areas-

Structure of Minor Program

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Curriculum structure

Semester	Course Code	Course Name	Teaching Scheme					Evaluation Scheme						
			L	P	T	Hours	Credits	IE1	IE2	ETE	TW	PR	OR	Total
V	MET5991	Fundamental of Robotics	4	-	-	4	4	20	30	50				100
	MET5992	Fundamentals of Robotics Lab		2		2	1				25		25	50
VI	MET6991	Robot Programming	4	-	-	4	4	20	30	50				100
	MET6992	Robot Programming Lab		2		2	1				25		25	50
VII	MET7991	Sensors and Actuators in Robotics	4			4	4	20	30	50				100
	MET7992	Seminar		4		4	2						50	50
VIII	MET8991 MET8992	Project		8		8	4				100		50	150
Total			14	16		28	20							600

1 Lecture hour = 1 Credit 2 Lab Hours = 1 Credit 1 Tutorial Hour = 1 Credit
Abbreviations are: L-Lecture, P-Practical, T-Tutorial, H- Hours, IE- Internal Evaluation, MTE- Mid Term Evaluation, ETE- End Term Evaluation, TW –Termwork, OR – Oral

Objectives of Minor program:

1. To familiarize the students with the significance of robotic system in agile and automated manufacturing processes.
2. To prepare the students to be conversant with robotic elements/ peripherals, their selection and interface with manufacturing equipments.
3. To familiarize the students with the basics of robot kinematics.

Outcomes of Minor program:

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

1. Acquire the skills in understanding robot language and programming.
2. Acquire the skill in robot task planning for problem solving.
3. Develop skills in understanding various sensors, robot peripherals and their use.
4. Develop skills in identifying areas in manufacturing, where robotics can be deployed for enhancing productivity

Course Syllabus

Program:	**B. Tech. (E&TC-Honors)**							**Semester: V**		
Course Name :	**Fundamentals of Robotics**							**Course Code : MET5991**		
Teaching Scheme				**Evaluation Scheme**						
Lecture	**Practical**	**Tutorial**	**Credit**	**IE1**	**IE2**	**ETE**	**TW**	**OR**	**PR**	**Total**
4	-	-	4	20	30	50	-	-	-	100

Pre-requisites:

- Basic Electronics Engineering
- Mechanics

Course Objectives:

1. To familiarize the students with the basic principles of robotics
2. To introduce the Various Parts of Robots and Fields of Robotics.
3. To acquaint the students with the knowledge of applications of robotics.
4. To prepare the students for understanding Planning and control in Robotics.

Course Outcomes:

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

CO1. Understand basics of robotics, types, classification and methodology.

CO2. Acquire the skills in understanding principles of robotics.

CO3. Acquire the skills in understanding robotics in inspection.

CO4. Develop skills in understanding industrial robotics.

CO5. Identifying opportunities for robotics to enhance productivity in manufacturing.

CO6. Learn Socio-economic aspects of Robotics.

Detailed Syllabus:

Unit	**Description**	**Duration (Hrs.)**
1.	**Introduction of Robotics** Historical development of Robotics, Definitions of Industrial Robot, Type and Classification of Robots, Asimov's laws of robotics, Methodology of robotics	**6**
2.	**Principles of Robotics** Robot configurations, Robot Components, Robot Degrees of Freedom, Work volume and work envelope, Robot Joints and symbols, Robot Coordinates, Robot Reference Frames, Resolution, accuracy and precision of Robot, Work cell control	**6**
3.	**Robotics in Inspection** Robots for Inspection: Robotic vision systems, image representation, objectrecognition and categorization, depth measurement.	**6**
4.	**Industrial Applications of Robotics** Introduction of processes like Coating, Deburring, cleaning, Die Casting, Molding, Material handling, Picking, Palletizing, Packaging, hospitals and patient care, sports and recreation, defense and surveillance industry, home automation, mining industry.	**6**
5.	**Planning and control in Robotics** Trajectory planning, position control, force control, Robot programing methods, hybrid control, Industrial and medical robotics: application in manufacturing processes	**6**
6.	**Socio-economic aspects of Robotics** A robot-based manufacturing system, robot cell design considerations and selection of robot, Robot Economics, Functional Safety in Robotic Application	**6**
	Total Hrs.	**36**

Textbooks:

1. M.P. Groover, “Automation, Production Systems & Computer Integrated Manufacturing”, PHI, 3rd Edition, 2018.
2. M.P. Groover, M.Naegel, “Industrial Robotics, Technology, Programming & Applications”, TMH, 2nd Edition, 2016.

Reference Books:

1. J.G. Keramas, “Robotics Technology Fundamentals”, Thompson Learning, 2nd Edition, 2016.
2. J.J.Craig “Introduction to Robotics Mechanics & Control”, Pearson Education, 3rd Edition, 2014.
3. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill Book, 2015.

Program: B. Tech. (E&TC-Honors)					Semester:V		
Course: Fundamentals of Robotics Lab					Code:MET5992		
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	TW	OR	PR	Total
	2		1	25	25		50

Prior knowledge of: Sensors, Control Systems and basic of programming is essential

Objectives:

The main objective of this course is to

1. To learn and understand the basics of fundamentals of robotics systems.
2. To be acquainted with different configuration of robotics system
3. To design MATLAB program for robotic configuration

Outcomes:

At the end of Laboratory work, the students will be able to:

1. Identify and understand the unique characteristics and components of robotics systems
2. Compare and understand various types of robotics systems
3. Design, simulate and test kinematic equations for robotic systems in MATALAB
4. Compare and understand various industrial application of robotics systems

General Guidelines: Any Six Experiments is to be performed.

Detailed Syllabus:

Expt. No.	List of Experiments
1	Study and analysis of robot grippers (includes the problems based on gripper force)
2	Demonstration of various robotic configurations using industrial robot
3	MATLAB program for simple kinematics of simple robot configuration
4	MATLAB program for inverse kinematics of simple robot configuration
5	To demonstrate simple robotic system using Matlab/ MscAdam / RoboAnalyser software
6	Study of configuration of robots and motion of robot manipulator
7	Study of pick and place industrial robot
8	One Industrial visit for Industrial robotic application

Virtual Lab Links

1. Mechanisms & Robotics Lab
http://vlabs.iitkgp.ernet.in/mr/
2. Robotics Application Lab
https://vlab.amrita.edu/?sub=3&brch=271&sim=1642&cnt=3525
3. Bio Inspired Robotics Virtual Lab
https://vlab.amrita.edu/?sub=3&brch=257

Program: B. Tech. (E&TC-Honors)									**Semester:** VI	
Course Name: Robot Programming									**Course code : MET6991**	
Teaching Scheme				**Evaluation Scheme**						
Lecture	**Practical**	**Tutorial**	**Credit**	**IE1**	**IE2**	**ETE**	**TW**	**OR**	**PR**	**Total**
4	-	-	4	20	30	50	-	-	50	150

Pre-requisites:

- Fundamentals of Robotics
- System Programming and Operating Systems

Course Objectives:

1. To introduce students with framework used for robot programming.
2. To impart the knowledge of robot programming language.
3. To explain the Virtual Robot Systems and their applications.

Course Outcomes:

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

1. Understand the significance of Robot operating system (ROS) and various ROS frameworks.
2. Learn the fundamentals robot programming language.
3. Acquire the knowledge of Robot Language: VAL Language.
4. Acquire the knowledge of Robot Language: RAPID Language.
5. Program robot as per application need.
6. Design practical robotics systems.

Detailed Syllabus:

Unit	**Description**	**Duration (Hrs.)**
1.	**Introduction to ROS** The ROS Equation, History, Distributions & difference from other meta-operating systems. ROS framework: Operating system and its various releases.	**6**
2.	**Basics of Robot Programming: Part 1** Introduction –The ROS Equation, History, Distributions & difference from other meta-operating systems. ROS framework: Operating system and its various releases.	**6**
3.	**Basics of Robot Programming: Part 2** Method, Robot Programming as a path in space, Motion interpolation, motion & task level Languages, Robot languages, Programming in suitable languages, characteristics of robot.	**6**
4.	**Robot Language: VAL Language** 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. VAL-II programming-basic commands, Simple problem using conditional statements, Simple pick and place applications, Production rate calculations using robot.	**6**
5.	**Robot Language: RAPID Language** Motion Instructions-Pick and place operation using Industrial robot- manual mode, automatic mode, and subroutine command-based programming. Move master command language-Introduction, syntax, simple problems. AML Language, elements and functions, Statements, constants andvariables-Program control statements, Motion, Sensor commands, Data processing	**6**
6.	**Virtual Robot Systems** Introduction to soft robotics; Robotic Process Automation (RPA); Computer Vision, AR & VR in Robotics. Multiple robot and machine Interference-Process chart-Simple problems-Virtual robotics, Robot studioonline software- Introduction, Jogging, components, work planning, program modules, input and output signals, Singularities, Collision detection, Repeatability measurement of robot, Robot economics.	**6**
	Total Hrs.	**36**

Textbooks:
1. Kumar Bipin, “Robot Operating System Cookbook”, Packet Publishing, 2018.
2. Lentin Joseph, “Robot Operating Systems (ROS) for Absolute Beginners, A press, 2018.
Reference Books:
1. Jason M O'Kane, “A Gentle Introduction to ROS”, CreateSpace, 2016.
2. Anis Koubaa, “Robot Operating System (ROS) – The Complete Reference (Vol.3), Springer, 2018.

Program: B. Tech. (E&TC-Honors)				**Semester :VI**			
Course: Robot Programming Lab				**Code :MET7992**			
Teaching Scheme				**Evaluation Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**TW**	**OR**	**PR**	**Total**
	2		1	25	25		50

Prior knowledge of Sensors Technology, Robot Drive Systems is essential

Objectives:

1. **To understand** robot programming methods
2. **To compare and understand different types of languages used for robot programming**
3. **To understand rules to design robot application using robot programming languages**

Outcomes:

At the end of Laboratory work, the students will be able to:

1. Explain the components of robot programming
2. Develop simple program to simulate robot movements
3. Develop robot program for specific application
4. Describe the safety rules in robot handling

General Guidelines: Any Six Experiments is to be performed.

Detailed Syllabus:

Expt. No.	**List of Experiments**
1	Programming on VAL Language
2	Programming on VAL-II Language
3	Programming on RAPID Language
4	Programming on AML Language
5	Demonstrate Industrial Robot programming using VAL II or equivalent.
6	Programming the robot for pick and place operation using any robot
7	Robot Programming for Colour identification/shape identification/path tracking
8	Industrial visit and its report on industrial applications of robots

Text Books:

1. S. R.Deb, “Robotics technology and flexible automation”, Tata McGraw Hill publishing company limited, 1994.
2. Mikell. P. Groover, “Industrial Robotics Technology”, Programming and Applications, McGraw Hill Co, 1995.
3. Robotcs Lab manual, 2007.

Reference Books:

1. Klafter. R.D, Chmielewski.T.A. and Noggin’s., “Robot Engineering : An Integrated Approach”, Prentice Hall of India Pvt. Ltd.,1994.
2. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., “Robotics control, sensing, vision and intelligence”, McGraw Hill Book co, 1987.
3. Craig. J. J. “Introduction to Robotics mechanics and control”, Addison-Wesley, 1999..

Program:	**B. Tech. (E&TC-Honors)**	**Semester:**	**VII**
Course Name	**Sensors and Actuators in Robotics**	**Course code :MET7991**	

Teaching Scheme				**Evaluation Scheme**						
Lecture	**Practical**	**Tutorial**	**Credit**	**IE1**	**IE2**	**ETE**	**TW**	**OR**	**PR**	**Total**
4	-	-	4	20	30	50	-	-	-	100

Prior Knowledge of

- Basic Electronics Engineering, Basic Electrical Engineering
- Image Processing, Fundamentals of Robotics, Sensors and Automation is essential

Course Objectives:

1. To introduce the various parts of electronics in the field of Robotics.
2. To explain students the need of embedded system technology for robot building.
3. To familiarize with the selection of appropriate sensors and actuators in robotic applications.
4. To help students understand about the smart real-time robot system technologies

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

1. Selection of suitable embedded boards for robots.
2. Understanding the concepts of robotics & automation and working of Robot.
3. Analyze the function of sensors and actuators in the Robot.
4. Write program to use a Robot for a typical application.
5. Develop machine vision-based algorithm for robotic tasks.
6. Apply the knowledge of sensors, embedded systems and actuators for industrial robot development.

Detailed Syllabus:

Unit	**Description**	**Duration (Hrs.)**
1.	**Review of Electronics in Robotics** Fundamentals of electronic blocks in robotics, Traditional and Mechatronics approach, Data conversion devices, sensors, microsensors, transducers, signal processing devices, relays, contactors and timers. Microprocessors controllers and PLCs	**6**
2.	**Sensors in Robotics: Part 1** Transducers and sensors, Sensors in robotics, Principles and applications of the following types of sensors- Proximity Sensors, Photo Electric Sensors, Laser Scanners, Position sensors – Piezo Electric Sensor, LVDT, Resolvers. Encoders: Absolute and Incremental: - Optical, Magnetic, Capacitive, pneumatic Position Sensors	**6**
3.	**Sensors in Robotics: Part 2** Range Sensors: Range Finders, Laser Range Meters, Touch Sensors, Force and torque sensors. Safety Sensor: Light Curtain, Laser Area Scanner, Safety Switches;	**6**
4.	**Actuators in Robotics** Mechanical Actuation Systems, Electrical Actuation Systems, A.C. Motor, D.C. Motor, Stepper Motor, Hydraulic & Pneumatic Actuation Systems. Design of hydraulic circuits.	**6**
5.	**Machine vision in Robotics: Part 1** Introduction, Low level & High-level Vision, Sensing & Digitizing, Image Processing & analysis, Segmentation, Edge detection, **Machine vision algorithms,** Applications	**6**
6.	**Machine vision in Robotics: Part 2** Object Description & recognition, interpretation, Imaging based automatic sorting and inspection, image processing, imaging-based robot guidance, Application	**6**
	Total Hrs.	**36**

Textbooks:

1. M.P. Groover, “Automation, Production Systems & Computer Integrated Manufacturing”, PHI, 3rd Edition, 2012.
2. M.P. Groover, M.Naegel, “Industrial Robotics, Technology, Programming & Applications”, TMH, 2nd Edition, 2012.

Reference books:

1. Mike Wilson, “Implementation of Robotic Systems”, 2014

2. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill Book co, 2015.
3. S.R. Deb, “Robotics Technology and Flexible Automation”, TMH, 2nd Edition, 2018.

Program:	**B. Tech. (E&TC-Honors)**				**Semester:**	**VII /VIII**
Course:	**Seminar**				**Code:**	HET7992
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Practical**	**Credit**	**IE2**	**TW**	**OR**	**Total**
-	**4**	2			50	50

Prior Knowledge: -

Course Objectives:

1. To identify practical learning skills and concepts and learn to communicate it to society.
2. To encourage personal growth of students and development of effective communication skills

Course Outcomes: After learning the course, the students should be able to:

1. Get an overview of the current trends and Learn them in more details
2. Improve Practice written and oral presentations
3. Learn the research methods used in that specific field

Detailed Guidelines:

1. The student should let the course instructor know in advance the intended topic of the seminar.
2. The length of the seminar should be at most 30 minutes, including time at the end for questions from the audience.
3. Each seminar should be given by one single student.
4. The intended audience for the seminar are other students attending the course. Prepare the seminar accordingly.
5. The focus should be on main ideas rather than on technical details
6. The seminar guidelines mentioned in B.Tech (E&TC) structure will be followed for evaluation of performance and certification compliance.

Program:	**B. Tech. (E&TC-Honors)**			**Semester:**	**VII /VIII**
Course:	**Project**			**Code:**	MET8991
Teaching Scheme			**Evaluation Scheme**		
Lecture	**Practical**	**Credit**	**IE2**	**TW**	**OR**	**Total**
-	**8**	4		100	50	150

Prior Knowledge of: basics of sensors, circuit simulation and design **is essential.**

Course Objectives:

1. To test students' knowledge of course implementation.
2. To make students ready for robot programming and automation

Course Outcomes: After learning the course, the students should be able to:

1. Solve real time problems observed in industry.
2. Deal with industrial and general-purpose robotic automation

Detailed Guidelines:

1. The students are encouraging to take projects for developing software solutions and hardware platforms using the concept of course taken under the certification.
2. The project guidelines mentioned in B. Tech (E&TC) structure will be followed for evaluation of performance and certification compliance.

Higher Study Scope: PhD. Research Centre at PCCOE.

- Computer Engineering
- E&TC Engineering
- Mechanical Engineering

Features of PhD Research Centers

- Experienced Research Guides
- Separate Research Laboratories, Library, licensed software, recent hardware and other Facilities
- Good support for Publications.
- Justified and clear evaluation systems
- Defined rules and regulations for evaluation and submission.
- Effective Course work conductions

"There are no secrets to success. It is the result of preparation, hard work, learning from failure."

– Colin Powell

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