M.Tech – PE&ED

R24

Academic Regulations
Course Structure
&
Syllabus

PRAGATI ENGINEERING COLLEGE
(An Autonomous Institution)
ADB Road, Surampalem, Kakinada District, A.P.-533 437
(Approved by AICTE, New Delhi & Permanently Affiliated to JNTUK, Kakinada)
(Recognized by UGC under sections 2 (f) and 12 (b) of UGC act, 1956)

M.Tech

(Effective for the students admitted from the Academic Year **2024-25** onwards)

Learning is Supreme Deity

ACADEMIC REGULATIONS R24 FOR M. Tech (REGULAR) DEGREE COURSE

Applicable for the students of M. Tech (Regular) Course from the Academic Year 2024-25 onwards. The M. Tech Degree of Pragati Engineering College(Autonomous) shall be conferred on candidates who are admitted to the program and who fulfill all the requirements for the award of the Degree.

1.0 ELIGIBILITY FOR ADMISSIONS

Admission to the above program shall be made subject to eligibility, qualification and specialization as prescribed by the State Government and Affiliating University and College from time to time.

2.0 AWARD OF M. Tech DEGREE

2.1 A student shall be declared eligible for the award of the M. Tech Degree, if he pursues a course of study in not less than two and not more than four academic years.

2.2 **The student shall register for all 68 credits and secure all the 68 credits**.

2.3 The minimum instruction days in each semester are 90.

3.0 A. PROGRAMMES OF STUDY

The following specializations are offered by various departments for the M. Tech Programme of study.

1. **M.Tech- Power Electronics and Electrical Drives**
2. **M.Tech- CAD/CAM**
3. **M.Tech- VLSI System Design**
4. **M.Tech- Computer Science and Engineering**

and any other course as approved by AICTE/ University from time to time.

3.0 B. Departments offering M. Tech Programmes with specializations are noted below:

EEE	**M.Tech- Power Electronics and Electrical Drives**
ME	**M.Tech- CAD/CAM**
ECE	**M.Tech- VLSI System Design**
CSE	**M.Tech- Computer Science and Engineering**

4.0 ATTENDANCE

4.1 **A student shall be eligible to write End Semester Examinations if he acquires a minimum of 75% of attendance in aggregate of all the subjects.**

4.2 **Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester shall be granted by the Committee.**

4.3 **Shortage of Attendance below 65% in aggregate shall not be condoned.**

4.4 **Students whose shortage of attendance is not condoned in any semester are not eligible to write their end semester examination of that class.**

4.5 **A prescribed fee shall be payable towards condonation of shortage of attendance.**

4.6 **A student shall not be promoted to the next semester unless he satisfies the attendance requirement of the present semester, as applicable. They may seek readmission into that semester when offered next. If any candidate fulfills the attendance requirement in the present semester, he shall not be eligible for readmission into the same class.**

5.0 EVALUATION

The performance of the candidate in each semester shall be evaluated subject-wise, with a maximum of 100 marks for theory and 100 marks for practicals on the basis of Internal Evaluation and End Semester Examination.

5.1 For the **theory subjects** 60 marks shall be awarded based on the performance in the End Semester Examination and 40 marks shall be awarded based on the Internal Evaluation. The internal evaluation shall be made based on the **average** of the marks secured in the two Mid Term-Examinations conducted-one in the middle of the Semester and the other immediately after the completion of instruction. Each mid term examination shall be conducted for a total duration of 120 minutes with 4 questions (without choice) each question for 10 marks. Semester End Exam Paper contains FIVE mandatory questions (one question from one unit) with internal choice, each carrying 12 marks for a total of 60 marks.

5.2 For **Practical subjects**, 60 marks shall be awarded based on the performance in the End Semester Examinations and 40 marks shall be awarded as internal marks, based on the day to day work-10 marks, Record-10 marks and the remaining 20 marks to be awarded by conducting an internal laboratory test. The end examination shall be conducted by the examiners, with a breakup marks of Procedure-15, Experimentation-25, Results-10 , Viva-voce-10.

5.3 For **Technical seminar**, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the department in a report form and shall make an oral presentation before the Project Review Committee consisting of Head of the Department, Supervisor and two other senior faculty members of the department. For Technical seminar, there will be only internal evaluation of 100 marks. A candidate has to secure a minimum of 50% of marks to be declared successful. Out of 100 marks, supervisor awards 40% marks and remaining 60% marks are awarded by the project review committee.

5.4 A candidate shall be deemed to have secured the minimum academic requirement in a subject if he secures a minimum of 40% of marks in the End semester Examination and a minimum aggregate of 50% of the total marks in the End Semester Examination and Internal Evaluation taken together.

5.5 In case the candidate does not secure the minimum academic requirement in any subject (as specified in 5.4) he has to reappear for the End semester Examination in that subject. A candidate shall be given a chance to re-register for each subject provided the internal marks secured by a candidate are less than 50% and has failed in the end examination. In such a case, the candidate must re-register for the subject(s) and secure the required minimum attendance. The candidate's attendance in the re-registered subject(s) shall be calculated separately to decide upon his eligibility for writing the end examination in those subject(s). In the event of the student taking another chance, his internal marks and end examination marks obtained in the previous attempt stand cancelled. For re-registration the candidates have to apply to the college by paying the requisite fees before the start of the semester in which re-registration is required.

5.6 In case the candidate secures less than the required attendance in any re registered subject (s), he shall not be permitted to write the End Examination in that subject. He shall again re-register the subject when next offered

5.7 Laboratory examination for M. Tech. programmes must be conducted with two Examiners, one of them being the Laboratory Class Teacher or teacher from the same department and the second examiner shall be appointed by the Principal from the panel of examiners submitted by the respective HoD.

5.8 Student is allowed to register for 12 week SWAYAM / NPTEL MOOC courses (recommended by BoS Chairman) and obtain required credits during II Semester itself. In any case, if a student fails in obtaining credits, he is allowed to repeat the initially opted course / change to another MOOC course or regular course and will be considered as regular candidate only. After successful completion, by the end of III Semester, he needs to submit the course certificate (through HoD) to the exam section to perform credit transfer.

5.9 In addition to credit courses, for completing the programme and obtaining degree, a student needs to complete audit courses. Audit courses will be conducted, evaluated as normal credit courses, and the assessment will be graded as Pass or Fail.

5.10 Students shall undergo mandatory summer **internship** (2 credits) for a minimum of eight weeks duration at the end of II semester of the Programme/Summer Break. A student will be required to submit a summer internship report to the concerned department and appear for an oral presentation before the committee. The Committee comprises of Head of the Department and two faculty. The report and the oral presentation shall carry 40% and 60% weightages respectively. For internship, there will be only internal evaluation of 100 marks in the III semester. A candidate has to secure a minimum of 50% of marks to be declared successful.

6.0 EVALUATION OF PROJECT WORK(part-1 and Part-2)

Every candidate shall be required to submit a thesis or dissertation on a topic approved by the Project Review Committee.

6.1 For Project evaluation, out of 200 marks, 80 marks shall be for Internal Evaluation(40 internal marks for Project work Part-I and remaining 40 internal marks for project work Part-II) and 120 marks for the End Examination (Viva–Voce).

6.2 Student has to secure 40% of marks in the Viva–Voce examination and a minimum aggregate of 50% of total marks in Viva–Voce examination and Internal Evaluation taken together.

6.3 A Project Review Committee (PRC) shall be constituted with Head of the Department and two other senior faculty members.

6.4 Registration of Project Work: A candidate is permitted to register for the project work after satisfying the attendance requirement of all the subjects, both theory and practical.

6.5 After satisfying 6.4, a candidate has to submit, in consultation with his project supervisor, the title, objective and plan of action of his project work for approval. The student can initiate the Project work, only after obtaining the approval from the Project Review Committee (PRC).

6.6 If a candidate wishes to change his supervisor or topic of the project, he can do so with the approval of the Project Review Committee (PRC). However, the Project Review Committee (PRC) shall examine whether or not the change of topic/supervisor leads to a major change of his initial plans of project proposal. If yes, his date of registration for the project work starts from the date of change of Supervisor or topic as the case may be.

6.7 A candidate shall submit his status report in two stages at least with a gap of 3 months between them.

6.8 The work on the project shall be initiated at the beginning of the II year and the duration of the project is two semesters. A candidate is permitted to submit Project Thesis only after successful completion of all theory and practical course with the approval of PRC not earlier than 40 weeks from the date of registration of the project work. The candidate has to pass all the theory and practical subjects before submission of the Thesis.

6.9 The candidate may be allowed to submit the project report, if the project work is published or accepted in a reputed national or international journal or conference.

6.10 Three copies of the Project Thesis certified by the supervisor shall be submitted to the department along with plagiarism report (<40%).

6.11 The thesis shall be adjudicated by one examiner selected by the Principal. For this, the Head of the Department shall submit a panel of five examiners, eminent in that field, with the help of the guide concerned and other PRC Members.

6.12 If the report of the examiner is not favourable, the candidate shall revise and resubmit the Thesis, in the time frame as decided by the PRC. If the report of the examiner is still unfavorable, the thesis shall be summarily rejected. The candidate has to re-register for the project and complete the project within the stipulated time after taking the approval from the Principal.

6.13 The Head of the Department shall coordinate and make arrangements for the conduct of Viva-Voce examination.

6.14 If the candidate failed in the Viva-Voce examination, the candidate shall retake the Viva-Voce examination only after three months. If he failed again the second Viva-Voce examination, the candidate has to re-register for the project and complete the project within the stipulated time after taking the approval from the Principal.

7.0 Cumulative Grade Point Average (CGPA)

Marks Range (Max – 100)	Letter Grade	Level (G)	Grade Point
≥ 90	S	Excellent (S)	10
≥80 to <90	A	Very Good (A)	9
≥70 to <80	B	Good (B)	8
≥60 to <70	C	Fair (C)	7
≥50 to <60	D	Satisfactory (D)	6
<50	F	Fail (F)	0
		Absent	0

Computation of SGPA

The following procedure is to be adopted to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

The SGPA **is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e**

$$SGPA\ (Si) = \sum (Ci \times Gi) / \sum Ci$$

Where Ci is the number of credits of the i^{th} course and Gi is the grade point scored by the student in the i^{th} course.

Computation of CGPA

The CGPA **is also calculated in the same manner taking into account all the courses undergone by a student over all the semester of a programme, i.e.**

$$CGPA = \sum (Ci \times Si) / \sum Ci$$

Where Si is the SGPA of the i^{th} semester and Ci is the total number of credits in that semester. The SGPA and CGPA shall be rounded off to TWO decimal points and reported in the transcripts.

8.0 AWARD OF DEGREE AND CLASS

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of M. Tech. Degree he shall be placed in one of the following four classes:

Class Awarded	CGPA to be secured	
First Class with Distinction	≥ 7.75 without backlog history	**From the CGPA secured from 68 Credits.**
First Class	≥ 6.75	
Second Class	≥ 5.75 to < 6.75	

9.0 WITHHOLDING OF RESULTS

If the student has not paid the dues, if any, or if any case of indiscipline is pending against him, the result of the student will be withheld. His degree will be withheld in such cases.

10.0 TRANSITORY REGULATIONS

Discontinued or detained candidates are eligible for re-admission into same or equivalent subjects at a time as and when offered.

11.1 GENERAL

11.2 Wherever the words “he”, “him”, “his”, occur in the regulations, they include “she”, “her”, “hers”.

11.3 The academic regulation should be read as a whole for the purpose of any interpretation.

11.4 In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Principal is final.

11.5 The College may change or amend the academic regulations or syllabi at any time and the changes or amendments made shall be applicable to all the students with effect from the dates notified by the College.

PRAGATI ENGINEERING COLLEGE: SURAMPALEM

R24

(Autonomous)

DEPARTMENT ELECTRICAL AND ELECTRONICS ENGINEERING

R24 M.TECH PE&ED COURSE STRUCTURE

I Semester

S.No	Category	Course Code	Course Title	L	P	C
1	Program Core	24051T01	Switched Mode Power Converters	3	0	3
2	Program Core	24051T02	Power Electronic Control of DC Drives	3	0	3
4	**PROGRAM ELECTIVE-I**			3	0	3
	Program Elective	24051T03	Modern Control Theory			
	Program Elective	24051T04	Digital Controllers			
	Program Elective	24051T05	Machine Modeling Analysis			
5	**PROGRAM ELECTIVE –II**			3	0	3
	Program Elective	24051T06	Smart Grid Technologies			
	Program Elective	24051T07	Power Quality & Custom Power Devices			
	Program Elective	24051T08	FACTS Controllers			
6	Credit Course	24RM1T01	Research Methodology and IPR	2	0	2
7	Program Core	24052L01	Advanced Power Converters Laboratory	0	4	2
8	Program Core	24052L02	Design and Simulation of Power Electronic Circuits Laboratory	0	4	2
9	Audit Course	24051A01	Audit Course-1*	2	0	0
			Total Credits			**18**

***Student has to choose any one audit course listed at the end of the course structure.**

II Semester

S.No	Category	Course Code	Course Title	L	P	C
1	Program Core	24052T09	Advanced Microcontroller based Systems	3	0	3
2	Program Core	24052T10	Advanced Electric AC Drives	3	0	3
4	**PROGRAM ELECTIVE-III**			3	0	3
	Program Elective	24052T11	Special Machines.			
	Program Elective	24052T12	Optimization Techniques.			
	Program Elective	24052T13	Electrical Distribution Systems.			
5	**PROGRAM ELECTIVE –IV**			3	0	3
	Program Elective	24052T14	Electric and Hybrid Electric Vehicles.			
	Program Elective	24052T15	Renewable Energy Technologies.			
	Program Elective	24052T16	AI Techniques to Electrical Engineering.			
6	Program Core	24052L03	Power Converters and Drives Laboratory	0	4	2
7	Program Core	24052L04	Microcontroller Laboratory	0	4	2
8	Mini Project	24052S01	Technical Seminar	2	0	2
9	Audit Course	24052A02	Audit Course-2*	2	0	0
			Total Credits			**18**

***Student has to choose any one audit course listed at the end of the course structure.**

***8 Weeks Mandatory Industrial Training/Internship during summer / semester break to be evaluated in III Semester**

III Semester

S.No	Category	Subject Code	Course Title	L	P	C
1	**PROGRAM ELECTIVE-V**			3	0	3
	MOOCS	24053M01	MOOCS (NPTEL)-12 Week Course Recommended By The Department Relevant To The Program. **(OR)**			
	Program Elective	24053T17 24053T18 24053T19	i) Battery and Energy Storage Systems ii) Energy Auditing, Conservation and Management iii) HVDC Transmission			
2	**OPEN ELECTIVE**			3	0	3
	MOOCS	24053M02	MOOCS (NPTEL)-12 Week Course Recommended By The Department Relevant To The Program. **(OR)**			
	Open Elective		Courses offered by other departments in the college i) Nano Technology (ME) ii) IOT Applications (ECE) iii) Principles of Cyber Security (CSE)			
3	Internship	24053I01	**Internship**	0	0	2
4	Project	24053P01	**Project Work Part-I**	0	20	8
			Total Credits			**16**

Students going for Industrial Project/Thesis will complete these courses through MOOCs.

IV Semester

S.No	Category	Subject Code	Course Title	L	P	C
1	Project	24054P01	**Project Work Part-II**	0	32	16
			Total Credits			**16**

NOTE:

- 8 Weeks Mandatory Industrial Training/Internship during summer / semester break
- ***Audit Course 1 :**
  1)Writing Skills for Research Paper
  2)Value Education
- ***Audit Course 2 :**
  1) Pedagogy Studies
  2) Personally Development Through Life Environment Skills.

I Semester

SWITCHED MODE POWER CONVERSION

Course Category	Program core	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Concepts of electrical circuit analysis and power electronics.	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To understand the control operation of non-sinusoidal DC-DC converters.
2	To understand the basic operation of resonant converters.
3	To understand the control operation of isolated DC-DC converters.
4	To understand the control schemes of DC-DC converters and designing of magnetic components.
5	To understand the modeling and control design of switch mode conversion based on linearization and how to analyse the switch mode converters using small-signal analysis.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive level**
CO1	Analyze the control operation of non-isolated switch mode converters.	K4
CO2	Analyze the operation of resonant converters and soft switching.	K4
CO3	Analyze the operation of isolated switch mode converters.	K4
CO4	Analyze the control schemes for resonant converters and design of magnetic components.	K4
CO5	Analyze the design of non-isolated switch mode converters based on linearization.	K4

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	3	2	3	2
CO2	3	2	3	2
CO3	3	2	3	2
CO4	3	2	3	2
CO5	3	2	3	2

COURSE CONTENT	
UNIT I	**Non-isolated switch mode converters:** Control of DC-DC converters: Buck converters, Boost converters, Buck-Boost converter, CUK Converter, Converter realization with non-ideal components.
UNIT II	**Resonant converters:** Basic resonant circuit concepts, series resonant circuits, parallel resonant circuits, zero current switching quasi-resonant buck converter, zero current switching quasi-resonant boost converter, zero voltage switching quasi-resonant buck converter, zero voltage switching quasi-resonant boost converter.
UNIT III	**Isolated switched mode converters:** Forwarded converter, flyback converter, push-pull converter, half-bridge converter, full bridge converter
UNIT IV	**Control schemes of switching converters:** Voltage control, Current control, control scheme for resonant converters, proportional integral controller. Magnetic design consideration: Transformers design, dc inductor and capacitor design.
UNIT V	**Modeling and Control design based on linearization:** Formulation of averaged models for buck and boost converters average circuits models, small – signal analysis and linearization. **Control design based on linearization:** Transfer function of converters, control design, large signal issues in voltage-mode and current-mode control.

TEXT BOOKS	
1.	Power Electronics – IssaBatareseh, John Wiley publications,2004
2.	Power switching converters-simonAng, Alejandro olive, CRC Press (Taylor & Francis group).
3.	lements of Power Electronics – Philip T. Krein, Oxford University press.
REFERENCE BOOKS	
1.	Power Electronics: converters Applications & Design – Mohan, Undeland, Robbins-Wiley publications
2.	Ned Mohan, Power Electronics, John Wiley and Sons.
3.	V.Jagganatham, Power Electronics: Devices and Circuits, PHI.
WEB RESOURCES	
1.	www.peg.ee.iisc.ernet.in/people/faculty/vram/smpc/smpcbook.pdf
2.	http://uni-site.ir/khuelec/wp-content/uploads/Mohan-Power-Electronics.pdf

PRAGATI ENGINEERING COLLEGE: SURAMPALEM

R24

(Autonomous)

DEPARTMENT ELECTRICAL AND ELECTRONICS ENGINEERING

I Semester

POWER ELECTRONIC CONTROL OF DC DRIVES

Course Category	Program core	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Knowledge of Power Electronics and Machines	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To study the operation of single phase converter fed DC Drives
2	To study the operation of three phase converter fed DC Drives
3	To study modeling concepts of AC – DC converters fed drive components.
4	To study the operation of DC- DC converter fed DC drives.
5	To study the operation of closed loop control based DC-DC converters fed DC drives

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Analyze single phase converter fed DC drives.	K4
CO2	Analyze three phase converter fed DC drives.	K4
CO3	Analyze the two quadrants and four quadrant controls of DC motor drives	K4
CO4	Develop the mathematical models of DC drive components.	K3
CO5	Analyze the four quadrant and closed loop control of DC-DC converter fed DC drive	K4

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	2	3	2
CO2	2	2	3	2
CO3	2	2	3	2
CO4	2	2	3	2
CO5	2	2	3	2

COURSE CONTENT	
UNIT I	**Introduction on single phase converter fed DC motor drive:** Basic power electronic drive system, components, stability of power electronic drive, single phase full-converter and half-convertor fed dc drives for continuous and discontinuous mode of operation. Four quadrant operation of drive using dual converter.

UNIT II	**Three phase AC-DC converter fed DC motor drive:** Three phase full-converter and half-convertor fed dc drives for continuous and discontinuous mode of operation. Four quadrant operation of drive using three phase dual converter. Pulsating torque
UNIT III	**Modeling of AC-DC convertor fed DC drive components & design of controller:** Transfer function of Dc motor and load, convertor, current and speed controllers, current and speed feedback elements. Design of current controller and speed controller. Closed loop two quadrant DC motor drive, closed loop four quadrant DC motor drive, introduction to simulation of DC motor drive.
UNIT IV	**DC-DC converter fed DC motor drive:** Four quadrant DC-DC convertor fed dc motor drive, steady state analysis of DC-DC converter dc motor drive, pulsating torques.
UNIT V	**Closed loop operation of DC-DC convertor fed dc motor drive:** Design of current controller, design of speed controller, modeling of current and speed controller, introduction to simulation of speed controlled dc motor drive

TEXT BOOKS	
1.	Electrical Motor Drives Modeling, Analysis and Control – R. Krishnan, Prentice HallIndia.
2.	Power Semiconductor Controlled Drives – G.K. Dubey.Prentice Hall India.
3.	Power Electronics and Motor control – Shepherd, Hulley, Liang-II Edition, Cambridge University Press
REFERENCE BOOKS	
1.	Power electronic circuits, devices and applications – M.H.Rashid – PHI.
2.	Murphy J. M. D. and Turnbull F. G., "Power Electronics Control of AC Motors", Pregamon Press.1990.
WEB RESOURCES	
1.	www.iare.ac.in/sites/default/files/lecture_notes/sd%20lecture%20notes.pdf
2.	http://shodganga.inflibnet.ac.in
3.	https://www.slideshare.net/psksiva13/63814075-electricaldrivesandcontrollecturenotes

I Semester

MODERN CONTROL THEORY (Program Elective-I)

Course Category	Program Elective-I	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Control Systems, differential equations	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To facilitate the evolution of state variable approach for the analysis of control systems.
2	To examine the importance of controllability and observability in modern control engineering.
3	To enable students to analyze various types of nonlinearities & construction of trajectories using describing functions.
4	To enable students to analyze various types of nonlinearities & construction of trajectories using phase plane analysis.
5	To study the analysis of stability and instability of continuous time invariant system

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive level**
CO1	Understanding the state variable approach is suitable for higher order.	K2
CO2	To analyze the concepts of controllability and observability.	K4
CO3	To analyze the various non-linearities through describing functions and phase plane analysis.	K4
CO4	To analyze the various non-linearity's through phase plane analysis	K4
CO5	Know the typical issues of stability and instability of continuous time invariant systems	K1

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)				
	PO1	**PO2**	**PO3**	**PSO1**
CO1	1	2	3	1
CO2	1	2	3	1
CO3	1	2	3	1
CO4	1	2	3	1
CO5	1	2	3	1

COURSE CONTENT	
UNIT I	**State Variable Analysis** The concept of state – State Equations for Dynamic systems, State diagram - Linear Continuous time model for physical systems – Existence and Uniqueness of Solutions to Continuous, Time State Equations – Solutions – Linear Time Invariant Continuous, Time State Equations, State transition matrix and it's properties.
UNIT II	**State Variable Techniques** General concept of Controllability - General concept of Observability Controllability tests for Continuous &Time Invariant systems, Observability tests for Continuous &Time Invariant systems - Controllability and Observability of state model in Jordan Canonical form - Controllability and Observability Canonical forms of State model – State feedback controller design through pole assignment.
UNIT III	**Non Linear Systems – I** Introduction – Non Linear Systems – Types of Nonlinearities – Saturation – Dead Zone – Backlash – Jump Phenomenon etc; - Singular Points – Introduction to Linearization of nonlinear systems, properties of Non Linear Systems – Describing function – describing function analysis of nonlinear systems- Stability analysis of Nonlinear systems through describing functions.
UNIT IV	**Non Linear Systems – II** Introduction to phase plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase plane analysis of nonlinear control systems.
UNIT V	**Stability Analysis** Stability in the sense of Lyapunov, Lyapunov's stability and Lyapunov's instability theorems – Stability Analysis of the Linear Continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method.

TEXT BOOKS	
1.	Modern Control System Theory by M. Gopal – New Age International – 1984
2.	Modern Control Engineering by Ogata. K – Prentice Hall – 1997
3.	Nonlinear systems, Hassan K. Klalil, Prentice Hall, 1996
REFERENCE BOOKS	
1.	Modern control systems, Richard C. Dorf and Robert H. Bishop, 11th Edition, Pearson Edu, India, 2009
2.	B.N. Sarkar, Advance Control Systems, PHI
WEB RESOURCES	
1.	http://www.ece.rutgers.edu/~gajic/psfiles/chap5.pdf
2.	https://nptel.ac.in/courses/108103007/
3.	https://www.studyindia.com/Pdf_Viewer/web/pdfviewer.aspx?ID=39805&file=3281Brogan_SI9a8.pdf

PRAGATI ENGINEERING COLLEGE: SURAMPALEM

R24

(Autonomous)

DEPARTMENT ELECTRICAL AND ELECTRONICS ENGINEERING

I Semester

DIGITAL CONTROLLERS (Program Elective –I)

Course Category	Program Elective-I	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Basic concepts of switching theory & logic design and fundamentals of micro controllers.	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To understand the architecture of PIC micro controller.
2	To understand the architecture of DSP processor and their interface.
3	To understand how to write the program for DSP processor using assembly Programming.
4	To understand the different types of FPGA and configurations.
5	o understand the basics of programming in Xilinx

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive level**
CO1	Know the interfacing circuits for input and output to PIC micro controllers.	K2
CO2	Know the interfacing circuits for input and output to DSP processors	K2
CO3	Know how to write ALP for DSP processors.	K2
CO4	Know the operation of ADC in DSP and Event Manager	K2
CO5	Design PWM controls for power electronic circuits using FPGA.	K5

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	2	3	1
CO2	2	2	3	1
CO3	2	2	3	1
CO4	2	2	3	1
CO5	2	2	3	1

COURSE CONTENT	
UNIT I	**PIC MICROCONTROLLERS** PIC Microcontrollers: Overview and Features, PIC 16C6X/7X, FSR(File Selection Register) [Indirect Data Memory Address Pointer], PIC Reset Actions, PIC Oscillator Connections, PIC Memory Organizations, PIC PIC 16C6X/7X Instructions, Addressing Modes, I/O Ports, Interrupts in PIC 16C61/71, PIC 16C61/71 Timers, PIC 16C71 Analog-to-Digital Converter (ADC).

UNIT II	**INTRODUCTION TO DSP** Introduction to the C2xx DSP core and code generation, The components of the C2xx DSP core, Mapping external devices to the C2xx core , peripherals and Peripheral Interface , System configuration registers , Memory , Types of Physical Memory , memory Addressing Modes , Assembly Programming using C2xx DSP, Instruction Set, Software Tools.
UNIT III	**I/O & CONTROL REGISTERS** Pin Multiplexing (MUX) and General Purpose I/O Overview, Multiplexing and General Purpose I/O Control Registers .Introduction to Interrupts, Interrupt Hierarchy, Interrupt Control Registers, Initializing and Servicing Interrupts in Software.
UNIT IV	**ADC & EVENT MANAGER** ADC Overview, Operation of the ADC in the DSP , Overview of the Event manager (EV), Event Manager Interrupts , General Purpose (GP) Timers , Compare UNITs, Capture UNITs And Quadrature Enclosed Pulse (QEP) Circuitry , General Event Manager Information
UNIT V	Introduction to Field Programmable Gate Arrays – CPLD Vs FPGA – Types of FPGA , Xilinx XC3000 series , Configurable logic Blocks (CLB), Input/ Output Block (IOB) – Programmable Interconnect Point (PIP) – Xilinx 4000 series – HDL programming – overview of Spartan 3E and Virtex II pro FPGA boards- case study.

TEXT BOOKS	
1.	Microcontrollers-Theory and Applications by Ajay V Deshmukh, McGrawHills
2.	Microcontrollers by Kennith J ayala, Thomsonpublishers
3.	Microprocessor and Microcontrollers by ProfC.R.Sarma.
REFERENCE BOOKS	
1.	Hamid.A.Toliyat and Steven G.Campbell"DSP Based Electro Mechanical Motion Control " CRC Press New York ,2004.
2.	XC 3000 series datasheets (version 3.1). Xilinx,Inc.,USA,1998.
3.	Wayne Wolf," FPGA based system design ", Prentice hall, 2004.
WEB RESOURCES	
1.	http://cs.hadassah.ac.il/staff/martin/embedded/slide04-1.pdf
2.	www.nptel.ac.in/courses/108105057/Pdf/Lesson-20.pdf

I Semester

MACHINE MODELING AND ANALYSIS (Program Elective-I)

Course Category	Program Elective-I	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Electrical machines & Special machines	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To know the concepts of generalized theory of electrical machines.
2	To represent the DC and AC machines as Basic Two Pole machine.
3	To model the electrical machines with voltage, current, torque and speed equations.
4	To investigate the steady state and transient behavior of the electrical machines.
5	To understand the dynamic behavior of the AC machines.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive level**
CO1	Apply knowledge of behavior of DC motors to model and analyze for different applications.	K3
CO2	Analyze the characteristics of different types of DC motors to design suitable controllers	K4
CO3	Apply the knowledge of reference frame theory for AC machines to model the induction and Synchronous machines.	K3
CO4	Apply knowledge of behavior of DC motors to model and analyze for different applications.	K3
CO5	Analyze the characteristics of different types of DC motors to design suitable controllers	K4

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)				
	PO1	**PO2**	**PO3**	**PSO1**
CO1	1	2	3	1
CO2	1	2	3	1
CO3	1	2	3	1
CO4	1	2	3	1
CO5	1	2	3	1

COURSE CONTENT	
UNIT I	**Basic concepts of Modeling** Basic two-pole machine representation of Commutator machines, representations of 3-phase synchronous machine with and without damper bars and 3-phase induction machine, Kron's primitive Machine voltage, current and torque equations

UNIT II	**DC Machine Modeling** Mathematical model of separately excited D.C motor – Steady state analysis-transient State analysis-sudden application of inertia load-transfer function of separately excited D.C motor- Mathematical model of D.C Series motor, Shunt motor-Linearization techniques for small perturbations
UNIT III	**Reference frame theory& Modeling of single-phase Induction Machines** Linear transformation-Phase transformation - three phase to two phase transformation (abc to αβ0) and vice-versa, transformation to rotating reference frame, (αβ0 to d q 0) and vice versa -Power equivalence- Mathematical modeling of single phase induction machines.
UNIT IV	**Modeling of three phase Induction Machine** Generalized model in arbitrary reference frame-Derivation of commonly used induction machine models- Synchronously rotating reference frame model, Stator reference frame model-Rotor reference frame model--power equation, electromagnetic torque equation, state space model in induction motor with flux linkages as variables
UNIT V	**Modeling of Synchronous Machine** Synchronous machine inductances –derivation of voltage equations in the rotor's dq0 reference frame electromagnetic torque-current in terms of flux linkages-three phase synchronous motor. State space models with flux linkages as variables.

TEXT BOOKS	
1.	Electric Motor Drives - Modeling, Analysis& control -R.Krishnan- Pearson Publications- 1st edition -2002
2.	Analysis of Electrical Machinery and Drive systems – P.C.Krause, Oleg Wasynczuk, Scott D.Sudhoff – Second Edition-IEEE Press.
3.	Dynamic simulation of Electric machinery using Matlab / Simulink –CheeMunOng- Prentice Hall
REFERENCE BOOKS	
1.	P.S.Bhimbra,'' Generalised theory of Electrical Machines''-Fifth edition, Khanna publishers.
2.	Vedam Subryamanhyam, Thyristor Control of Electric Drives, Tata McGraw Hill
WEB RESOURCES	
1.	.http://www.motor-design.com/cmsAdmin/uploads/induction_motor_modelling.pdf
2.	https://nptel.ac.in/courses/108106023/
3.	http://www.ee.iitm.ac.in/2016/08/ee5201/

I Semester

SMART GRID TECHNOLOGIES (Program Elective-II)

Course Category	Program Elective – II	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Basic knowledge on smart concept communication protocols, renewable energy systems and electronic circuits.	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To understand concept of smart grid and developments on smart grid.
2	To understand smart grid technologies and application of smart grid concept in hybrid electric vehicles etc.
3	To have knowledge on smart substations, feeder automation and application for monitoring and protection.
4	To have knowledge on micro grids and distributed energy systems.
5	To know power quality aspects in smart grid

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive level**
CO1	Understand smart grids and analyse the smart grid policies and developments in smart grids.	K4
CO2	Develop concepts of smart grid technologies in hybrid electrical vehicles etc.	K5
CO3	Understand smart substations, feeder automation, GIS etc.	K2
CO4	Analyze micro grids and distributed generation systems.	K4
CO5	Analyze the effect of power quality in smart grid and to understand latest developments in ICT for smart grid.	K4

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	3	2	2	1
CO2	3	2	2	1
CO3	3	2	2	1
CO4	3	2	2	1
CO5	3	2	2	1

COURSE CONTENT	
UNIT I	**Introduction to Smart Grid:** Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient &Self Healing Grid, Present development & International policies on Smart Grid. Case study of Smart Grid.
UNIT II	**Smart Grid Technologies: Part 1:** Introduction to Smart Meters, Real Time Pricing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation and Phase

	Shifting Transformers.
UNIT III	**Smart Grid Technologies: Part 2:** Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) and their application for monitoring & protection, Smart storage like battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU).
UNIT IV	**Microgrids and Distributed Energy Resources:** Concept of micro grid, need and applications of microgrid, formation of microgrid, Issues of interconnection, protection and control of microgrid. Variable speed wind generators, fuel cells, microturbines, Captive power plants, Integration of renewable energy sources.
UNIT V	**Power Quality Management in Smart Grid:** Power Quality and EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit. **Information and Communication Technology for Smart Grid:** Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN).

TEXT BOOKS	
1.	Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley
2.	Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response",CRC Press
3.	JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama,"Smart Grid: Technology and Applications", Wiley
4.	Jean Claude Sabonnadière, NouredineHadjsaïd, "Smart Grids", Wiley Blackwell 19
REFERENCE BOOKS	
1.	Peter S. Fox Penner, "Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities", Island Press; 1 edition 8 Jun 2010
2.	S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks." Institution of Engineering and Technology, 30 Jun 2009
3.	Stuart Borlase, "Smart Grids (Power Engineering)", CRC Press
4.	Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability: 1", Artech House Publishers July 2011
WEB RESOURCES	
1.	https://www.engineering.unsw.edu.au/electrical.../sites/.../GSOE9141_S12015.pdf
2.	http://ctijabalpur.com/Download/Study-Material/Smart%20Grid%20Notes.pdf

I Semester

POWER QUALITY AND CUSTOM POWER DEVICES (Program Elective-II)

Course Category	Program Elective-II	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Knowledge on electric circuit analysis, power systems and power electronics.	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To understand significance of power quality and power quality parameters.
2	To know types of transient over voltages and protection of transient voltages.
3	To understand harmonics, their effects, harmonic indices and harmonic minimization techniques.
4	To understand long duration voltage variation and flicker
5	To know power quality aspects in distributed generation.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive level**
CO1	Identify the issues related to power quality in power systems.	K2
CO2	Categorize short and long duration voltage variations in power systems.	K3
CO3	Analyze the effects of harmonies and study of different mitigation techniques.	K4
CO4	Illustrate the importance of custom power devices and their applications.	K3
CO5	Compare different compensation techniques to minimize power quality disturbances.	K4

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	3	3	1
CO2	2	3	3	1
CO3	2	3	3	1
CO4	2	3	3	1
CO5	2	3	3	1

COURSE CONTENT	
UNIT I	**Introduction to power quality:** Overview of Power Quality, Concern about the Power Quality, General Classes of Power Quality Problems, Transients, Long-Duration Voltage Variations, Short, Duration Voltage Variations, Voltage Unbalance, Waveform Distortion, Voltage fluctuation, Power Frequency Variations, Power Quality Terms, Voltage Sags and Interruptions - Sources of Sags and Interruptions, Nonlinear loads.
UNIT II	**Transient and long Duration Voltage Variations:** Source of Transient Over Voltages - Principles of Over Voltage Protection, Devices for Over Voltage Protection, Utility Capacitor Switching Transients, Utility Lightning Protection, Load Switching Transient Problems.

	Principles of Regulating the Voltage, Device for Voltage Regulation, Utility Voltage Regulator Application, Capacitor for Voltage Regulation, End-user Capacitor Application, Regulating Utility Voltage with Distributed Resources.
UNIT III	**Harmonic Distortion and solutions** Voltage vs. Current Distortion, Harmonics vs. Transients - Power System Quantities under Non-sinusoidal Conditions, Harmonic Indices, Sources of harmonics, Locating Sources of Harmonics, System Response Characteristics, Effects of Harmonic Distortion, Inter harmonics, Harmonic Solutions Harmonic Distortion Evaluation, Devices for Controlling Harmonic Distortion, Harmonic Filter Design, Standards on Harmonics
UNIT IV	**Custom Power Devices:** Custom Power and custom power devices, voltage source inverters, reactive power and harmonic compensation devices, compensation of voltage interruptions and current interruptions, static series and shunt compensators, compensation in distributed systems, interaction with distribution equipment installation considerations.
UNIT V	**Application of custom power devices in Power Systems:** Static and hybrid sources transfer switches, solid state current limiter – Solid static breaker, P-Q theory –Control of P and Q , Dynamic Voltage Restorer (DVR): Operation and control –interline power Flow Controller (IPFC): Operation and control of Unified Power Quality Conditioner (UPQC): Generalized Power quality conditioner.

TEXT BOOKS	
1.	Electrical Power Systems Quality, Dugan R C, McGranaghan M F, Santoso S, and Beaty H W, Second Edition, McGraw-Hill, 2002.
2.	Understanding Power Quality Problems: Voltage Sags and Interruptions, Bollen M H J, First Edition, IEEE Press; 2000.
3.	Guidebook on Custom Power Devices, Technical Report, Published by EPRI, Nov 2000
4.	Power Quality Enhancement Using Custom Power Devices – Power Electronics and Power Systems, Gerard Ledwich, ArindamGhosh, Kluwer Academic Publishers, 2002.
REFERENCE BOOKS	
1.	Power Qulity Primer , Kennedy B W First Edition ,MC Graw Hill -2000.
2.	Power System Harmonics , Arrilliaga J and Watson N R , Secons Edition , Jophan Wiley & Sons 2003.
3	Electric Power Quality control Techniques, W. E. Kazibwe and M. H. Sendaula, Van Nostrad Reinhold, New York.
4	Power Quality c.shankaran, CRC Press, 2001
5	Harmonics and Power Systems –Franciso C.DE LA Rosa-CRC Press (Taylor & Francis)
6	Power Quality in Power systems and Electrical Machines-EwaldF.fuchs, MohammadA.S. Masoum-Elsevier
7	Instantaneous power theory and application to power conditioning, H. Akagiet.al., IEEE Press, 2007.
8	Custom Power Devices - An Introduction, Arindam Ghosh and Gerard Ledwich, Springer, 2002
9.	A Review of Compensating Type Custom Power Devices for Power Quality Improvement, Yash Pal et.al., Joint International Conference on Power System Technology and IEEE Power India Conference, 2008. POWERCON 2008.
WEB RESOURCES	
1.	www.tnb.com/eel/docs/furse/bs7671.pdf
2.	http://prof.usb.ve/bueno/Libros/power_quality-0849310407.pdf

I Semester

FACTSCONTROLLERS (Program Elective-II)

PRAGATI ENGINEERING COLLEGE: SURAMPALEM

R24

(Autonomous)

DEPARTMENT ELECTRICAL AND ELECTRONICS ENGINEERING

Course Category	Program Elective -II	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Concepts on Power Electronics and Power Systems	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To study the performance improvements of transmission system with FACTS.
2	To study the effect of static shunt compensation.
3	To study the effect of SVC and STATCOM.
4	To study the effect of static series compensation.
5	To study the effect of UPFC and IPFC

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive level**
CO1	Know the performance improvement of transmission system with FACTS.	K1
CO2	Get the knowledge of effect of static shunt compensation.	K4
CO3	Understand the Effect of SVC and STATCOM	K2
CO4	Get the knowledge of effect of static series compensation	K4
CO5	Know the effect of UPFC. & IPFC	K4

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	3	2	2	1
CO2	3	2	2	1
CO3	3	2	2	1
CO4	3	2	2	1
CO5	3	2	2	1

COURSE CONTENT	
UNIT I	FACTS concepts, Transmission interconnections, power flow in an AC System, loading capability limits, Dynamic stability considerations, importance of controllable parameters, basic types of FACTS controllers, benefits from FACTS controllers.
UNIT II	Basic concept of voltage and current source converters, comparison of current source converters with voltage source converters. **Static shunt compensation:** Objectives of shunt compensation, midpoint voltage regulation, voltage instability prevention, improvement of transient stability, Power oscillation damping, methods of controllable var generation: variable impedance type static var generators, switching converter type

	var generators, hybrid var generators
UNIT III	**SVC and STATCOM operating principles:** The regulation slope ,V-I characteristics, transient stability enhancement and power oscillation damping, operating point control and summary of compensation control.
UNIT IV	**Static series compensators:** Concept of series capacitive compensation, improvement of transient stability, power oscillation damping, functional requirements. GTO thyristor controlled series capacitor (GSC), thyristor switched series capacitor (TSSC), and thyristor controlled series capacitor (TCSC), Static Synchronous Series Compensator (SSSC), control schemes for GSC, TSSC,TCSC and SSSC.
UNIT V	**UPFC and IPFC:** Basic operating principle, conventional transmission control capabilities, independent real and reactive power flow control. IPFC operating principle, control schemes for IPFC.

TEXT BOOKS	
1.	"Understanding FACTS Devices" N.G.Hingorani and L.Guygi, IEEE Press. Indian Edition is available:--Standard Publications
2.	Sang.Y.HandJohn.A.T, "Flexible AC Transmission systems" IEEE Press (2006).
REFERENCE BOOKS	
1.	K.R Padiyar, Facts Control in Power Transmission and Distribution system, Anshan
2.	HVDC & FACTS Controllers: applications of static converters in power systems- Vijay K.Sood-Springer publishers.
WEB RESOURCES	
1.	http://ethesis.nitrkl.ac.in/2243/1/Project_Thesis_Final.pdf
2.	http://www.site.uottawa.ca/~rhabash/ELG4125FACTS.pdf

I Semester

RESEARCH METHODOLOGY AND IPR

Course Category	Credit Course	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Exposure to good communication skills, proficiency in Basic English, Science and good writing skills.	**Continuous Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES: The objectives of the course are to	
1	To understand the knowledge on basics of research and its types.
2	To impart the concept of Literature Review, Technical Reading, Attributions and Citations.
3	To know the Ethics in Engineering Research.
4	To know the concepts of Intellectual Property Rights in Engineering.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Explain the meaning of engineering research and apply to develop an appropriate framework for research studies.	K2
CO2	Identify the procedure of Literature Review, Technical Reading, etc. and apply to develop a research design during their project work.	K2
CO3	Explain and apply the fundamentals of patent laws and drafting procedure in their research works.	K2
CO4	Demonstrate the copyright laws, subject matters of copyrights, designs etc. to apply in patent filing.	K3
CO5	Identify the new developments in IPR and employ the applications of computer software in writing/filing patents in future.	K2

K1-Remembering, K2-Understanding, K3-Applying, K4-Analyzing, K5-Evaluating, K6-Creating

Contribution of Course Outcomes towards achievement of Program Outcomes
(1 – Low, 2 - Medium, 3 – High)

CO	**PO1**	**PO2**	**PO3**
CO1	2		3
CO2	2	3	
CO3			2
CO4		2	
CO5	2		3

COURSE CONTENT

UNIT – I:

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

UNIT – II:

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT – III:

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT – IV:

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT – V:

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR.

TEXT BOOKS:

1. C.R. Kothari , 2nd Edition, “Research Methodology: Methods and Techniques”.
2. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step-by-Step Guide for beginners”.

REFERENCE BOOKS:

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students.
2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”.
3. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd, 2007.
4. Mayall, “Industrial Design”, McGraw Hill, 1992.
5. Niebel, “Product Design”, McGraw Hill, 1974.

WEB REFERENCES:

1. https://www.coursera.org/learn/research-methodologies
2. https://archive.nptel.ac.in/courses/127/106/127106227/
3. https://archive.nptel.ac.in/courses/121/106/121106007/
4. https://www.studocu.com/in/course/anna-university/research-methodology-and-ipr/5881061

PRAGATI ENGINEERING COLLEGE: SURAMPALEM

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DEPARTMENT ELECTRICAL AND ELECTRONICS ENGINEERING

ADVANCED POWER CONVERTERSLABORATORY

Course Category	Lab course	**Course Code**	
Course Type	LAB	**L-T-P-C**	0-0-4-2
Prerequisites	Concepts of Advanced Power Converters of PWM	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To understand the characteristics of Thyristor, MOSFET & IGBT by simulation.
2	To understand the operation of power electronics converters by simulation.
3	To understand how to implement PWM techniques in simulation.
4	To understand and analyze the speed control of AC motors in open and closed loop in simulation

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive level**
CO1	Analyze the characteristics of power converter devices.	K4
CO2	Analyze the characteristics of DC motor drives .	K4
CO3	Analyze Control DC drives using hardware controllers	K4
CO4	Analyze various options available for the drive circuit requirements.	K4

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	3	2	3	2
CO2	3	2	3	2
CO3	3	2	3	2
CO4	3	2	3	2

List of experiments: Any 10 of the following experiments are to be conducted	
S.No	**Name of the Experiment**
1.	Modeling of DC Machine using MATLAB.
2.	Modeling of synchronous Machine using MATLAB.
3.	Modeling of induction Machine using MATLAB.
4.	Study of thyristors controlled DC Drive
5.	Regenerative/ Dynamic braking operation for DC Motor- Study using software.
6.	Study of DC-DC Non-Isolated Buck Converter.
7.	Study of DC-DC Non-Isolated Boost Converter.
8.	Single phase dual converter in circulating current & non circulating current mode of operation.
9.	Determination of Input Power Factor And Harmonic Factor For Single Phase Semi Converter And Full Converter.
10.	Vector Control Based Speed Control of Induction Motor.
11.	Experimental study for speed Control of separately excited DC motor.

PRAGATI ENGINEERING COLLEGE: SURAMPALEM

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(Autonomous)

DEPARTMENT ELECTRICAL AND ELECTRONICS ENGINEERING

I Semester

DESIGN AND SIMULATION OF POWER ELECTRONIC CIRCUITS LABORATORY

Course Category	Lab course	**Course Code**	
Course Type	LAB	**L-T-P-C**	0-0-4-2
Prerequisites	Concepts of Power Electronics & Closed loop control.	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To understand the characteristics of Thyristor, MOSFET & IGBT by simulation.
2	To understand the operation of power electronics converters by simulation.
3	To understand how to implement PWM techniques in simulation.
4	To understand and analyze the speed control of AC motors in open and closed loop in simulation

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive level**
CO1	Analyze the characteristics of power semiconductor devices in simulation.	K4
CO2	Analyze the operation of various power electronic converters in simulation.	K4
CO3	Analyze and implementing the speed controlling techniques for AC machines in simulation.	K4
CO4	Analyze and implementing PWM techniques in simulation.	K4

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	3	2	3	2
CO2	3	2	3	2
CO3	3	2	3	2
CO4	3	2	3	2

List of experiments: Any 10 of the following experiments are to be conducted	
S.No	**Name of the Experiment**
1.	Switching characteristics of Thyristor, MOSFET,IGBT using PSPICE Simulation
2.	PSPICE Simulation of Single phase full converter using R-L load, R-L- E load with and without LCFilter.
3.	PSPICE Simulation of Three phase full converter using R-L-E Load.
4.	PSPICE Simulation of Single phase AC Voltage controller with PWMcontrol for RL load.
5.	PSPICE Simulation of Three phase AC Voltage controller using RL load.
6.	PSPICE Simulation of Single phase inverter with sinusoidal PWM control for R- load
7.	PSPICE Simulation of Three phase inverter with Sinusoidal PWM control for R-Load.
8.	PSPICE Simulation of DC-DC Boost converter.
9.	Three phase converter fed DC motor using Matlab/ Simulink
10.	Development and Simulation of 3-phase PWM Inverter with sinusoidal pulse-width modulation using Matlab/ Simulink
11.	Characteristics of induction machines under balanced and symmetrical conditions for the following using Matlab/ Simulink a. dq model in synchronous reference frame b. dq model in stator reference frame c. dq model in rotor reference frame
12.	Single phase IGBT based fully controlled rectifier with PWM control using Matlab- Sim power block set.
13.	Three phase IGBT based ac voltage controller with PWM control using Matlab- Sim power block set

I Semester

WRITING SKILLS FOR RESEARCH PAPER

Course Category	Audit Course	**Course Code**	
Course Type	Theory	**L-T-P-C**	2-0-0-0
Pre requisites	It is expected that the students should have good communication skills, proficiency in basic English, Science and good writing skills.	**Continuous Internal Assessment** **Semester End Examination** **Total Marks**	**40** **60** **100**

COURSEOBJECTIVES: The objectives of the course are to	
1	To identify and use appropriate research resources, including books, articles, and websites.
2	To evaluate the credibility of information sources.
3	To write a clear and concise research question.
4	To organize their research findings in a logical and persuasive way.
5	To use correct grammar and punctuation in documenting their sources correctly.

COURSEOUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Analyze and interpret data by using data to write clear, concise technical reports, research articles and practice professional writing style	K3&K4
CO2	Understand and apply an appropriate plan, assemble a protocol, writing task and perform original research with ethics.	K2
CO3	Identify and apply the proper methods to do to the literature and scope of the research work plan.	K2
CO4	Demonstrate improved writing skills and apply to reflect the growth in writing and communicate outcomes of the research effectively.	K3
CO5	Apply the proper methodology for writing the research reports making use of appropriate phrases.	K3

K1-Remembering, K2-Understanding, K3-Applying, K4-Analyzing, K5-Evaluating, K6-Creating

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

CO	PO1	PO2	PO3
CO1	3	3	
CO2		2	2
CO3	3	3	
CO4	3	3	2
CO5		3	

COURSE CONTENT

UNIT – I:

Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness, Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising.

UNIT – II:

Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT – III:

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

UNIT – IV:

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, and skills are needed when writing the Conclusions.

UNIT – V:

Useful phrases, how to ensure paper is as good as it could possibly be the first time submission.

TEXT BOOKS:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books).
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press.

REFERENCE BOOKS:

1.Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.
2. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

WEB REFERENCES:

1. https://www.scribbr.com/category/research-paper/
2. https://www.grammarly.com/blog/how-to-write-a-research-paper/
3. https://archive.nptel.ac.in/courses/110/105/110105091/

I Semester

VALUE EDUCATION

Course Category	Audit Course	**Course Code**	
Course Type	Theory	**L-T-P-C**	2-0-0-0
Prerequisites		**Continuous Internal Assessment** **Semester End Examination** **Total Marks**	**40** **60** **100**

COURSEOBJECTIVES: The objectives of the course are to	
1	Understand value of education and self- development.
2	Imbibegoodvaluesinstudents.
3	Lettheshouldknowabouttheimportanceofcharacter.

COURSEOUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Infertheknowledgeofself-development	K2
CO2	DescribetheimportanceofHumanvalues	K2
CO3	Developingtheoverallpersonality	K6

K1-Remembering, K2-Understanding, K3-Applying, K4-Analyzing, K5-Evaluating, K6-Creating

Contribution of Course Outcomes towards achievement of Program Outcomes
(1 – Low, 2 - Medium, 3 – High)

CO	**PO1**	**PO2**	**PO3**
CO1	2	3	
CO2		2	2
CO3	3	3	

COURSE CONTENT

UNIT–I: Valuesandself-development-Socialvaluesandindividualattitudes.Workethics,Indianvisionofhumanism.Moralandnon-moralvaluation,Standardsandprinciples,Valuejudgments.

UNIT–II: Importance of cultivation of values- Sense of duty, Devotion, Self-reliance,Confidence,Concentration.Truthfulness,Cleanliness,Honesty,Humanity,Poweroffaith,NationalUnity, Patriotism.Lovefornature,Discipline.

UNIT–III: PersonalityandBehaviourDevelopment-SoulandScientificattitude,PositiveThinking,Integrityanddiscipline,Punctuality,LoveandKindness,AvoidfaultThinking.

UNIT–IV: Freefromanger,Dignityoflabour-Universalbrotherhoodandreligioustolerance,True friendship, Happiness Vs suffering, love for truth,Awareofself-destructivehabits,AssociationandCooperation, Doing best forsavingnature.

UNIT–V: CharacterandCompetence-HolybooksvsBlindfaith,Self-management and Good health, Science of reincarnation, Equality, Nonviolence,Humility, Role of Women, All religions and same message, Mind your Mind, Self-control,Honesty,Studyingeffectively.

TEXT BOOKS:

1.
ValuesandEthicsfororganizationsTheoryandpractice,LatestEdition,Chakroborty,S.K., OxfordUniversityPress,NewDelhi

WEB REFERENCES:
1.https://nptel.ac.in/courses/109104068

PRAGATI ENGINEERING COLLEGE: SURAMPALEM

R24

(Autonomous)

DEPARTMENT ELECTRICAL AND ELECTRONICS ENGINEERING

II Semester

ADVANCEDMICRO-CONTROLLERBASEDSYSTEMS

Course Category	Program Core	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Brief idea of compensation techniques	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	DescribethearchitectureandfeaturesofIntel8051Processorandassemblylanguageprograms.
2	DescribethearchitectureandexplaintheinstructionsetofPICMicrocontrollers**.**
3	DescribethearchitectureandexplaintheinstructionsetofARMprocessor.
4	UnderstandRealtimesystem.
5	DevelopapplicationsusingMicrocontrollers.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive level**
CO1	Understand the architecture & Memory Organization of 8051 , Discuss the Instruction set of 8051 & Analyze the operation of timers & Counters.	K2
CO2	Understand the architecture & Memory organization of PIC16F877 , Discuss the Instruction set of PIC 16F877 & Understand the operation of Timers and ADC in PIC 16F877.	K2
CO3	Understand the architecture and memory organization of ARM processor; Define the advantages of 32 bit CPU & Develop simple programs for real time applications.	K2
O4	Understand Real time system. , Understand selection criteria for Real Time systems, Discuss case study of real time applications using C2000 microcontroller – Motor Control.	K2
CO5	Understand the interfacing of LED, LCD &keyboard, Illustrate the techniques of interfacing motors &sensors,and Differentiate the applications of Microcontrollers, DSPs & FPGAs.	K2

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)				
	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	3	2	1
CO2	2	3	2	1
CO3	2	3	2	1
CO4	2	3	2	1
CO5	2	3	2	1

COURSE CONTENT	
UNIT I	**Load Compensation** Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing – Load compensator as a voltage regulator – phase balancing and power factor correction of unsymmetrical loads- examples.
UNIT II	**Reactive power compensation in transmission system:** Steady state -Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation – examples Transient state - Characteristic time periods – passive shunt compensation – static compensations- series capacitor compensation –compensation using synchronous condensers –examples
UNIT III	**Reactive power coordination:** Objective – Mathematical modeling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances- steady –state variations – effects of under voltages – frequency – Harmonics, radio frequency and electromagnetic interferences
UNIT IV	**Distribution side Reactive power Management:** System losses –loss reduction methods – examples – Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banks **User side reactive power management:** KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations
UNIT V	**Reactive power management in electric traction systems and are furnaces:** Typical layout of traction systems – reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements– remedial measures –power factor of an arc furnace

TEXT BOOKS	
1.	Reactive power control in Electric power systems by T.J.E.Miller
2.	Reactive power Management by D.M.Tagare
REFERENCE BOOKS	
1.	Wolfgang Hofmann, Jurgen Schlabbach, Wolfgang Just “Reactive Power Compensation: A Practical Guide, April, 2012, Wiely publication.
WEB RESOURCES	
1.	http://ethesis.nitrkl.ac.in/2243/1/Project_Thesis_Final.pdf
2.	https://shodhganga.inflibnet.ac.in/bitstream/10603/62667/10/10_chapter_03.pdf

II Semester

ADVANCED ELECTRIC AC DRIVES

Course Category	Program Core	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Concepts of power electronics, electrical machines and closed loop control	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To analyze the VSI fed induction motor drive.
2	To Study the vector of Induction Motors
3	To study the performance of different types of BLDC motor drives.
4	To study different traction drives
5	o know the operation and control of switched reluctance motor & stepper motor.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive level**
CO1	Explain operation of induction motor and analyze speed control of AC drives by VSI feddrives.	K2
CO2	Understand vector control of induction motors.	K2
CO3	Understand operation of traction drives.	K2
CO4	Analyze control schemes to synchronous motor drives.	K4
CO5	Understand the control of switched reluctance motor & stepper motor.	K2

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	PO2	PO3	PSO1
CO1	3	3	3	2
CO2	3	3	3	2
CO3	3	3	3	2
CO4	3	3	3	2
CO5	3	3	3	2

COURSE CONTENT	
UNIT I	**3-phase induction motor drives–Part 1** Analysis of IM fed from non-sinusoidal supply, harmonic equivalent circuit, transient analysis –starting and plugging; variable frequency control, torque-slip relation, starting torque and braking torque, closed-loop VSI fed IM drive. Slip-ring IM control, closed-loop speed control with static rotor resistance, closed-loop speed control by using slip power recovery scheme.

UNIT II	**3-phase induction motor drives–Part 2** Concept of space vector, vector control of IM: direct or feed-back vector control, flux vector estimation, indirect or feed forward vector control, vector control of line side PWM converter, stator flux oriented vector control, vector control of converter fed inverter drive.
UNIT III	**Synchronous motor and BLDC motor drives** Variable frequency control of synchronous motor, closed-loop control of inverter fed synchronous motor drive. Permanent magnet synchronous motor drive. BLDC motor drives, VSIfed BLDC motor drives, back emf, phase current and torque waveforms, control of BLDCmotors with sensors, sensor-less control of BLDC motors
UNIT IV	**Traction drives** Motors employed in railway traction and road-vehicles, control of railway traction dc motors using ac-dc converters, control of railway traction ac motors using ac-dc and dc-ac converters, power electronic control circuits of electric vehicles and hybrid electric vehicles
UNIT V	**Switched reluctance and stepper motor drives** Switched reluctance motor operation and control: modes of operation, converter circuits closed loop speed control. Stepper motor characteristics drive circuits for uni-polar and bipolar steppermotors.

TEXT BOOKS	
1.	"Electric motor drives, modeling, analysis and control", R. Krishnan, PHI Publisher.
2.	"Control of electric drives", W. Leonhard, Springer Verilog
3.	"Vector control of AC machines", ArindamGhosh, Gerard Ledwich
4.	"Power Electronics: Converters,Application and design" ,Mohan, Undeland and Robbins, Wiley Publications
REFERENCE BOOKS	
1.	"Power control of AC motors", J.M.D. Murphy and F. G. Turnbul
2.	"Power semiconductor drives", G. K. Dubey, Printice Hall International
3.	"Fundamentals of electric drives", G. K. Dubey, Narosa Publishing House
WEB RESOURCES	
1.	http://ethesis.nitrkl.ac.in/5016/1/109EE0039.pdf
2.	http://s1.nonlinear.ir/epublish/book/Permanent_Magnet_Brushless_DC_Motor_Drives_and_Controls_1118188330.pdf
3.	http://kaliasgoldmedal.yolasite.com/resources/SEM/SRM.pdf

PRAGATI ENGINEERING COLLEGE: SURAMPALEM

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DEPARTMENT ELECTRICAL AND ELECTRONICS ENGINEERING

II Semester

SPECIAL MACHINES(Program Elective-III)

Course Category	Program Elective – III	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Concepts of Electrical machines.	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To know the concepts of special types of electrical machines.
2	To understand the different control schemes for PMSM.
3	To learn about the different sensor used in brushless DC motors.
4	To draw the characteristics of servo motors, tacho meters and SRM
5	To understand the concepts of linear induction motor.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive level**
CO1	Analyze the characteristics of different types of PM type brushless DC motors and design suitable controllers.	K4
CO2	Apply the knowledge of sensors used in PMSM which can be used for controllers and synchronous machines.	K3
CO3	Analyze the different controllers used in electrical machines to propose the suitability of drives for different industrial applications.	K4
CO4	Classify the types of DC linear motors and apply the knowledge of controllers to propose their application in real world.	K3
CO5	Evaluate the steady state and transient behavior linear induction motors.	K5

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)				
	PO1	**PO2**	**PO3**	**PSO1**
CO1	1	2	2	1
CO2	1	2	2	1
CO3	1	2	2	1
CO4	1	2	2	1
CO5	1	2	2	1

COURSE CONTENT	
UNIT I	**Stepper Motors** Constructional features, Principle of operation, Modes of excitation torque production in Variable Reluctance (VR) stepping motor, Dynamic characteristics, Drive systems and circuit foropen loop control, closed loop control of stepping motor.

UNIT II	**Permanent Magnet Synchronous Motors (PMSM) and Switched Reluctance Motors(SRM)** PMSM: Power electronic controllers, Torque speed characteristics, Self control, Vector control, Current control. SRM: Constructional features, Principle of operation. Torque equation, Characteristics, Control Techniques, Drive concept.
UNIT III	**Permanent Magnet Brushless DC Motors** Concept of electronic commutation, Hall sensors, Optical sensors, back emf detection, Multiphase Brushless motor, Square wave permanent magnet brushless motor drives, Torque andemf equation, Torque-speed characteristics, Speed control by microcontroller.
UNIT IV	Servomotors and AC Tachometers Servomotor – Types – Constructional features – Principle of Operation – Characteristics Control – Microprocessor based applications. AC Tachometers: Permanent magnet ac tachometer, AC induction tachometer, Schematic diagrams, Operating principle.
UNIT V	**Linear Motors** Linear Motors: Linear Induction Motor (LIM) Classification – Construction – Principle of operation – Concept of Current sheet –Goodness factor – DC Linear Motor (DCLM) types – Circuit equation – DCLM control-applications.

TEXT BOOKS	
1.	Miller, T.J.E. "Brushless Permanent Magnet and Reluctance Motor Drives", ClarendonPress, Oxford, 1989.
2.	Kenjo, T, "Stepping Motors and their Microprocessor control", Clarendon Press, Oxford,1989.
3.	Naser A and Boldea I, "Linear Electric Motors: Theory, Design and PracticalApplication", Prentice Hall Inc., New Jersey,1987
REFERENCE BOOKS	
1.	Special Electrical Machines-K.Venkataratnam- University press
2.	Floyd E Saner,"Servo Motor Applications", Pittman USA, 1993.
3.	Kenjo, T and Naganori, S "Permanent Magnet and brushless DC motors", ClarendonPress, Oxford, 1989.
4.	Generalized Theory of Electrical Machines – P.S.Bimbra-Khanna publications-5th edition-1995
WEB RESOURCES	
1.	www.nct-tech.edu.lk/Download/Technology%20Zone/Stepping%20Motors.pdf
2.	https://nptel.ac.in/syllabus/108104011/

PRAGATI ENGINEERING COLLEGE: SURAMPALEM

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DEPARTMENT ELECTRICAL AND ELECTRONICS ENGINEERING

II Semester

OPTIMIZATION TECHNIQUES (Program Elective-III)

Course Category	Program Elective – III	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Concepts of engineering mathematics and mathematical methods.	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To define an objective function and constraint functions in terms of design variables, and then state the optimization problem.
2	To state single variable and multi variable optimization problems, without and with constraints.
3	To explain linear programming technique to an optimization problem, define slack and surplus variables, by using Simplex method.
4	To study and explain nonlinear programming techniques, unconstrained or constrained, and define exterior and interior penalty functions for optimization problems.
5	To introduce evolutionary programming techniques.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive level**
CO1	State and formulate the optimization problem and Apply classical optimization techniques to minimize or maximize a multi-variable objective function, without or with constraints, and arrive at an optimal solution.	K3
CO2	Formulate a mathematical model and apply linear programming technique by using Simplex method. Also extend the concept of dual Simplex method for optimal solutions.	K4
CO3	Apply gradient and non-gradient methods to nonlinear optimization problems and use interior or exterior penalty functions for the constraints to derive the optimal solutions.	K3
CO4	Able to apply Genetic algorithms for simple electrical problems.	K3
CO5	Able to solve practical problems using PSO.	K5

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)				
	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	2	2	1
CO2	2	2	2	1
CO3	2	2	2	1
CO4	2	2	2	1
CO5	2	2	2	1

COURSE CONTENT	
UNIT I	**Introduction and Classical Optimization Techniques:** Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function – objective function surfaces – classification of Optimization problems. Single variable Optimization – multi variable Optimization without constraints – necessary and sufficient

	conditions for minimum/maximum – multivariable Optimization with equality constraints .Solution by method of Lagrange multipliers – multivariable Optimization with inequality constraints – Kuhn – Tucker conditions.
UNIT II	**Linear Programming** Standard form of a linear programming problem – geometry of linear programming problems – definitions and theorems – solution of a system of linear simultaneous equations – pivotal reduction of a general system of equations – motivation to the simplex method – simplex algorithm - Duality in Linear Programming – Dual Simplex method.
UNIT III	**Nonlinear Programming:** **Unconstrained cases -** One – dimensional minimization methods: Classification, Fibonacci method and Quadratic interpolation method - Univariate method, Powell's method and steepest descent method. **Constrained cases -** Characteristics of a constrained problem, Classification, Basic approach of Penalty Function method; Basic approaches of Interior and Exterior penalty function methods.Introduction to convex Programming Problem.
UNIT IV	**Introduction to Evolutionary Methods:** Evolutionary programming methods - Introduction to Genetic Algorithms (GA)– Control parameters – Number of generation, population size, selection, reproduction, crossover and mutation – Operator selection criteria – Simple mapping of objective function to fitness function– constraints – Genetic algorithm steps – Stopping criteria –Simple examples.
UNIT V	**Introduction to Swarm Intelligence Systems:** Swarm intelligence programming methods - Basic Partial Swarm Optimization – Method –Characteristic features of PSO procedure of the global version – Parameters of PSO (Simple PSO algorithm – Operators selection criteria – Fitness function constraints) – Comparison with other evolutionary techniques – Engineering applications of PSO.

TEXT BOOKS	
1.	"Engineering optimization: Theory and practice"-by S. S.Rao, New Age International (P) Limited, 3rd edition, 1998.
2.	Soft Computing with Matlab Programming by N.P.Padhy & S.P.Simson, Oxford University Press – 2015
3.	**"**Optimization methods in operations Research and Systems Analysis" by K.V.Mital and C.Mohan, New Age International (P) Limited, Publishers, 3rd edition, 1996.
REFERENCE BOOKS	
1.	Genetic Algorithms in search, optimization, and Machine Learning by David E.Goldberg,ISBN:978-81-7758-829-3, Pearsonby Dorling Kindersley (India) Pvt. Ltd.
2.	"Operations Research: An Introduction" by H.A.Taha, PHI pvt. Ltd., 6th edition.
3.	Linear Programming by G.Hadley.,Narosa Publishers.
WEB RESOURCES	
1.	ww.slideplayer.com/slide/5028943/
2.	https://nptel.ac.in/downloads/105108127/
3.	https://www.iare.ac.in/sites/default/files/lecture_notes/OT_LECTURE_NOTES_0.pdf

PRAGATI ENGINEERING COLLEGE: SURAMPALEM

R24

(Autonomous)

DEPARTMENT ELECTRICAL AND ELECTRONICS ENGINEERING

II Semester

ELECTRICAL DISTRIBUTION SYSTEMS (Program Elective-III)

Course Category	Program Elective – III	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Knowledge on basics of distribution systems, Compensation in electrical distribution systems, Circuit Analysis, concept of load modeling.	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To learn the importance of economic distribution of electrical energy
2	To analyze the distribution networks for V-drops, PLoss calculations and reactive power.
3	To understand the co-ordination of protection devices.
4	To impart knowledge of capacitive compensation/voltage control.
5	To understand the principles of voltage control.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive level**
CO1	Analyze a distribution system.	K4
CO2	Design equipment for compensation of losses in the distribution system.	K5
CO3	Design protective systems and co-ordinate the devices.	K5
CO4	Understand of capacitive compensation.	K4
CO5	Understand the principles of voltage control.	K4

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)				
	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	3	2	1
CO2	2	3	2	1
CO3	2	3	2	1
CO4	2	3	2	1
CO5	2	3	2	1

COURSE CONTENT	
UNIT I	**General :** Introduction to Distribution systems, an overview of the role of computers in distribution system planning-Load modeling and characteristics: definition of basic terms like demand factor, utilization factor, load factor, plant factor, diversity factor, coincidence factor, contribution factor and loss factor-Relationship between the load factor and loss factor – Classification of loads (Residential, Commercial, Agricultural and Industrial) and their characteristics.

UNIT II	**Distribution Feeders and Substations** : Design consideration of Distribution feeders: Radial and loop types of primary feeders, voltage levels, feeder-loading. Design practice of thesecondary distribution system. Location of Substations : Rating of a Distribution Substation,service area with 'n' primary feeders. Benefits derived through optimal location of substations.
UNIT III	**System analysis :** Voltage drop and power loss calculations : Derivation for volt-drop and power loss in lines, manual methods of solution for radial networks, three-phase balanced primary lines, non-three-phase primary lines.
UNIT IV	**Protective devices and coordination :** Objectives of distribution system protection, types of common faults and procedure for fault calculation. Protective Devices: Principle of operation of fuses, circuit reclosers, line sectionalizer and circuit breakers. Coordination of protective devices : General coordination procedure..
UNIT V	**Capacitive compensation for power factor control:** Different types of power capacitors, shunt and series capacitors, effect of shunt capacitors (Fixed and switched) power factor correction, capacitor location. Economic justification. Procedure to determine the best capacitor location. Voltage control: Equipment for voltage control, effect of series capacitors, effect of AVB/AVR, line drop compensation

TEXT BOOKS	
1.	"Electric Power Distribution System Engineering " byTuranGonen, Mc.Graw-Hill Book Company,1986.
2.	Electric Power Distribution-by A.S.Pabla, Tata McGraw-Hill PublishingCompany, 4th edition, 1997.
REFERENCE BOOKS	
1.	Electrical Distribution V.Kamaraju-McGraw Hill
2.	Handbook of Electrical Power Distribution – Gorti Ramamurthy-Universities press
WEB RESOURCES	
1.	http://www.tech.mtu.edu/~avsergue/EET3390/Lectures/CHAPTER6.pdf
2.	http://textofvideo.nptel.ac.in/108107112/lec1.pdf

II Semester

PRAGATI ENGINEERING COLLEGE: SURAMPALEM

R24

(Autonomous)

DEPARTMENT ELECTRICAL AND ELECTRONICS ENGINEERING

ELECTRIC AND HYBRID ELECTRIC VEHICLES (Program Elective-IV)

Course Category	Program Elective-IV	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Knowledge of Power Electronics and Electric Drives	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	Know the concept of electric vehicles and hybrid electric vehicles.
2	Familiar with different motors used for hybrid electric vehicles.
3	Know the concept of Plug-in hybrid electric vehicles
4	Know the concept of power electronics in hybrid electric vehicles
5	Know different EV Charging Method and Technologies.

COURSE OUTCOMES		**Cognitive level**
Upon successful completion of the course, the student will be able to:		
CO1	Know the concept of electric vehicles and hybrid electric vehicles.	K1
CO2	Familiar with different motors used for hybrid electric vehicles.	K2
CO3	Understand the power management of plug in Hybrid Electric Vehicle	K2
CO4	Understand the power converters used in hybrid electric vehicles	K2
CO5	Know different EV Charging Method and Technologies	K2

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**
CO1	2	2	3
CO2	2	2	3
CO3	2	2	3
CO4	2	2	3
CO5	2	2	3

COURSE CONTENT	
UNIT I	**Introduction:** Fundamentals of vehicle, components of conventional vehicle and propulsion load; Drive cycles and drive terrain; Concept of electric vehicle and hybrid electric vehicle, evolution of electric vehicles.
UNIT II	**Hybridization of Automobile:** History of hybrid vehicles, architectures of HEVs, series and parallel HEVs, complex HEVs.: Plug-in hybrid vehicle, constituents of PHEV, comparison of HEV and PHEV; Fuel Cell vehicles and its constituents.
UNIT III	**Plug-in Hybrid Electric Vehicle:** PHEVs and EREVs, blended PHEVs, PHEV Architectures, equivalent electric range of blended

	PHEVs; Fuel economy of PHEVs, power management of PHEVs, end-of-life battery for electric power grid support, vehicle to grid technology.
UNIT IV	**Power Electronics in HEVs:** Rectifiers used in HEVs, voltage ripples; Buck converter used in HEVs, non-isolated bidirectional DC-DC converter, regenerative braking, voltage source inverter, current source inverter, isolated bidirectional DC-DC converter, PWM rectifier in HEVs, EV and PHEV battery chargers.
UNIT V	**EV Charging :** AC Charging , DC Charging , Types of Charging Schemes, DC fast Charging Schemes , Smart Charging Schemes, Numerical Examples.

TEXT BOOKS	
1.	Pistooa G., "Power Sources , Models, Sustanability, Infrstructure and the market", Elsevier 2008
2.	Mi Chris, Masrur A., and Gao D.W., " Hybrid Electric Vehicle: Principles and Applications with Practical Perspectives" 1995
REFERENCE BOOKS	
1.	James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
2.	Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004
3.	Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003
WEB RESOURCES	
1.	https://nptel.ac.in/downloads/108103009/
2.	http://ecee.colorado.edu/~ecen2060/materials/lecture_notes/2060_HEV_1.pdf

II Semester

RENEWABLE ENERGY TECHNOLOGIES (Program Elective-IV)

Course Category	Program Elective – IV	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Basic idea of non-conventional energy sources	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To learn basic principle of solar energy.
2	To adoption of alternative energy sources for power generation and inter connection to grid.
3	To learn about the bio mass energy.
4	To learn alternative energy sources not based on sun. learn the operations of wind and photovoltaic power plants
5	To learn about the geo thermal energy.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive level**
CO1	Estimate the solar Energy.	K2
CO2	Describe the principle operation of induction and synchronous generator and its inter connection to grid.	K4
CO3	Understand the process of power generation through biomass energy.	K2
CO4	Understand the principle of operation of alternative energy sources not based on sun.	K4
CO5	Understand the Geo thermal energy.	K2

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)				
	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	3	2	1
CO2	2	3	2	1
CO3	2	3	2	1
CO4	2	3	2	1
CO5	2	3	2	1

COURSE CONTENT	
UNIT I	Solar Energy - Availability - Solar radiation data and measurement - Estimation of average solarradiation - Solar water heater types - Heat balance – Flat plate collector efficiency – Efficiencyof heat removal - Thermo siphon flow calculation - Forced circulation calculation – Evacuatedcollectors - Basics of solar concentrators Solar Energy Applications - Solar air heaters – SolarChimney - Crop driers - Passive solar system - Active solar systems - Water desalination -Output from solar still – Principle of solar ponds.

UNIT II	Wind Energy – Nature of wind – Characteristics – Variation with height and time – Power in wind – Aerodynamics of Wind turbine – Momentum theory – Basics of aerodynamics – Aero foils and their characteristics – HAWT – Blade element theory – Prandtl's lifting line theory (prescribed wake analysis) VAWT aerodynamics – Wind turbine loads – Aerodynamic loads in steady operation–Yawed operation and tower shadow. Wind Energy Conversion System – Sitting – Rotor selection –Annual energy output – Horizontal axis wind turbine (HAWT) – Vertical axis wind turbine (VAWT) – Rotor design considerations – Number of blades – Solidity - Blade profile –Upwind/Downwind – Yaw system – Tower – Braking system - Synchronous and asynchronous generators and loads – Integration of wind energy converters to electrical networks–Inverters–Control system – Requirement and strategies – Noise Applications of wind energy
UNIT III	Biomass energy - Bio fuel classification – Examples of thermo chemical, Pyrolysis, biochemical and agrochemical systems – Energy farming – Direct combustion for heat – Process heat and electricity– Ethanol production and use – Anaerobic digestion for biogas – Different digesters Digester sizing – Applications of Biogas - Operation with I.C. Engine
UNIT IV	Ocean Energy - OTEC Principle - Lambert's law of absorption - Open cycle and closed cycle -heat exchanger calculations – Major problems and operational experience. Tidal Power - Principles of power generation - components of power plant – Single and two basin systems – Turbines for tidal power - Estimation of energy – Maximum and minimum power ranges - tidal powerhouse. Wave Energy – Concept of energy and power from waves – Wave characteristics–period and wave velocities - Different wave energy conservation devices (Saltor duck, oscillating water column and dolphin types) – operational experience.
UNIT V	Geothermal Energy - Classification- Fundamentals of geophysics - Dry rock and hot aquifier energy analysis - Estimation of thermal power - Extraction techniques - Prime movers.

TEXT BOOKS	
1.	**Renewable Energy Resources / John Twidell and Tony Weir / E &F.N.Spon**
2.	Renewable Energy Resources Basic Principles and Applications / G.N.Tiwari and M.K.Ghosal / Narosa
3.	Solar Energy - Principles of thermal collection and storage/ S.P. Sukhatme / TMH
REFERENCE BOOKS	
1.	Solar Energy Thermal Processes,/Duffie& Beckman
2.	Solar Heating and Cooling / Kreith&Kreider, CRC press.
3.	Wind Energy Handbook / Tony Burton, David Sharpe, Nick Jenkins and Ervin Bossanyi / WileyWind Electrical Systems / S.N.Bhadra, D.Kastha and S.Banerjee / Oxford
4.	Biogas Technology - A Practical Hand Book / K.Khendelwal& S.S. Mahdi / McGrawHill.
WEB RESOURCES	
1.	http://www.cs.kumamoto-u.ac.jp/epslab/APSF/sub5.html
2.	https://nptel.ac.in/courses/117108141/

II Semester

AI TECHNIQUES TO ELECTRICAL ENGINEERING (Program Elective-IV)

Course Category	Program Elective – IV	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Basic knowledge on human biological systems, concept of optimization and electrical engineering.	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To have knowledge on concept of neural network.
2	To know different types of neural networks and training algorithms.
3	To understand the concept of genetic algorithm and its application in optimization.
4	To have the knowledge on fuzzy logic and design of fuzzy logic controllers.
5	To know the applications of AI Techniques in power electronics and DC drives.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive level**
CO1	Understand neural networks and analyze different types of neural networks.	K2
CO2	Design training algorithms for neural networks.	K5
CO3	Develop algorithms using genetic algorithm for optimization.	K3
CO4	Analyze and design fuzzy logic systems.	K4
CO5	Apply AI Techniques in power electronics and DC drives.	K3

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)				
	PO1	**PO2**	**PO3**	**PSO1**
CO1	3	2	2	1
CO2	3	2	2	1
CO3	3	2	2	1
CO4	3	2	2	1
CO5	3	2	2	1

COURSE CONTENT

UNIT I	**Introduction to Neural Networks** Introduction, Humans and Computers, Biological Neural Networks, Historical development of neural network, Terminology and Topology, Biological and artificial neuron models, Basic learning laws.
UNIT II	**Feed Forward Neural Networks** Introduction, Perceptron models: Discrete, continuous and multi-category, Training algorithms: Discrete and Continuous Perceptron Networks, Perceptron convergence theorem, Limitations and applications of the Perceptron model, Generalized delta learning rule, Feedforward recall and error back propagation training-Radial basis function algorithms-Hope field networks
UNIT III	**Genetic algorithms &Modelling-**introduction-encoding-fitness function-reproduction operators-genetic operators-cross over and mutation-generational cycle-convergence of genetic algorithm
UNIT IV	**Classical and Fuzzy Sets** Introduction to classical sets - properties, operations and relations; Fuzzy sets, membership, Uncertainty, operations, properties, fuzzy relations, cardinalities, membership functions. Fuzzy Logic System Components-Fuzzification, Membership value assignment, development of rule base and decision making system, defuzzification to crisp sets, defuzzification methods.
UNIT V	**Application of AI Techniques:** PWM Controllers -Selected harmonic elimination PWM Space vector PWM using neural network. Design of PI controller for speed control of DC motor using fuzzy logic-

TEXT BOOKS	
1.	Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan and Pai – PHI Publication.
2.	Introduction to Artificial Neural Systems - Jacek M. Zuarda, Jaico Publishing House, 1997.
3.	Modern Power Electronics and AC Drives –B.K.Bose-Pearson Publications
REFERENCE BOOKS	
1.	Genetic Algorithms- David E Goldberg. Pearson publications.
2.	M.C. Trivedi, Artificial Intelligence, Khanna Publishing House, Delhi
WEB RESOURCES	
1.	ttp://www.eolss.net/sample-chapters/c18/e6-43-23-04.pdf
2.	www.vssut.ac.in/lecture_notes/lecture1428643004.pdf
3.	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-825-techniques-in-artificial-intelligence-sma-5504-fall-2002/lecture-notes/

II Semester

PRAGATI ENGINEERING COLLEGE: SURAMPALEM

R24

(Autonomous)

DEPARTMENT ELECTRICAL AND ELECTRONICS ENGINEERING

POWER CONVERTERS AND DRIVES LABORATORY

Course Category	Lab course	**Course Code**	
Course Type	LAB	**L-T-P-C**	0-0-4-2
Prerequisites	Knowledge in Power Electronic Control of AC & DC Drives and Digital Controllers.	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To verify the operation of various converters and also their usage in the motor speed control application.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive level**
CO1	To analyze the working of phase-controlled converters, AC voltage controllers, DC-DC converters, and PWM inverters and analyze the speed control operation of power converter fed motors.	K4

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)				
	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	1	2	2

List of experiments: Any 10 of the following experiments are to be conducted	
S.No.	**Name of the Experiment**
1.	Single -Phase half controlled bridge converter with R and RL loads.
2.	Single -Phase AC Voltage Controller with R and RL Loads
3.	Operation of 3- phase Full-Converter on R & R-L loads...
4.	Performance & speed control of D.C. drive using 3-phase full Converter.
5.	Performance & Operation of a four quadrant Chopper on D.C. Drive
6.	Performance & Operation of a 3-phase A.C. Voltage controller on motor load...
7.	Single Phase IGBT based PWM Inverter on R & R-L load
8.	Operation of 3-phase IGBT based PWM Inverter on R & R-L load.
9.	Performance & speed control of 3 phase slip ring Induction motor by Static Rotor Resistance controller.
10.	Three phase PWM Pulse generation using PIC Micro controller
11.	PIC Microcontroller based speed control of three phase InductionMotor.
12.	DSP based V/F Control of 3 phase Induction motor..

II Semester

ADVANCEDMICROPROCESSORS&MICROCONTROLLERSLABORATORY

CourseCategory	ProfessionalCore	**Course Code**	
Course Type	Laboratory	**L-T-P-C**	3-0-0-3
Prerequisites	Advanced Microprocessor &Microcontrollers	**InternalAssessmentSemesterEndExamination TotalMarks**	30 70 100

CourseOutcomes:Thestudentwill beableto

COURSEOUTCOMES		**Cognitive level**
CO-1	DevelopassemblylevellanguageprogramusingMASM.	K3
CO-2	UnderstandInterfacingof8086Microprocessorwithperipheraldevices.	K2
CO-3	Developassemblylevel languageprogram using8051	K3

1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

TheMapping ofCOandPOon 3 pointscale{high-3,Medium-2,Low-1}is:

	PO-1	**PO-2**	**PO-3**	**PSO-1**
CO-1	**3**	**3**	**2**	**2**
CO-2	**3**	**1**	**2**	**2**
CO-3	**3**	**1**	**2**	**2**

LISTOFEXPERIMENTS(Any10ofthefollowingexperimentsaretobeconducted)

PART-A:IntroductiontoMASM/TASM.	
1	Arithmetic operation – Multi byte addition and subtraction, multiplication and division – Signedandunsigned arithmeticoperation, ASCII –Arithmetic operation.
2	Logicoperations–Shiftandrotate – ConvertingpackedBCDtounpackedBCD,BCDtoASCIIconversion.
3	By using string operation and Instruction prefix: Move block, Reverse string Sorting, Inserting,Deleting,Length of thestring, Stringcomparison.Sorting of anarray
PART-B:Interfaceusing8086	
4	PPIIntel 8255Interfaceusing8086
5	ProgrammableInterruptcontroller8259Interfaceusing8086
6	D/AInterfacethroughIntel8255
7	Keyboardanddisplayinterfacethrough Intel8279
8	ElevatorInterfaceusing8086
PART-C:Interfaceusing8051	
9	Arithmeticoperationsusing8051
10	Timerindifferentmodesusing8051
11	Serialcommunicationimplementationusing 8051
12	TrafficLight Controllerusing8051.
13	StepperMotorInterfacingUsing8051

II Semester

PRAGATI ENGINEERING COLLEGE: SURAMPALEM

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DEPARTMENT ELECTRICAL AND ELECTRONICS ENGINEERING

TECHNICAL SEMINAR

CourseCategory		**CourseCode**	
CourseType		**L-T-P-C**	2-0-0-2
Prerequisites		**Continuous Internal AssessmentSemesterEndExamination TotalMarks**	40 60 100

COURSEOBJECTIVES	
1	To identify and use appropriate research resources, including books, articles, and websites.
2	To evaluate the credibility of information sources.
3	To write a clear and concise research question
4	To organize their research findings in a logical and persuasive way.
5	To use correct grammar and punctuation.

COURSEOUTCOMES		
Uponsuccessfulcompletionofthecourse,thestudentwillbeableto:		**Cognitive Level**
CO1	Conductingathoroughassessmentoftheliteratureonachosenresearch topicthatcanhelptofindanygapsintheknowledgebaseanddevelopa research problem.	K4
CO2	CreateandprovideatechnicalSeminar in detail	K6

K1-Remembering,K2-Understanding,K3-Applying,K4-Analyzing,K5-Evaluating,K6-Creating

CO	**PO1**	**PO2**	**PO3**
CO1	3		
CO2		3	

II Semester

PEDAGOGYSTUDIES

CourseCategory	Audit Course	**CourseCode**	
CourseType	Theory	**L-T-P-C**	2-0-0-0
Prerequisites		**Continuous Internal AssessmentSemesterEndExamination TotalMarks**	40 60 100

COURSEOBJECTIVES	
1	ReviewexistingevidenceonthereviewtopictoinformprogrammedesignandpolicymakingundertakenbytheDfID,otheragenciesandresearchers.
2	Identifycriticalevidencegapstoguidethedevelopment.

COURSEOUTCOMES		
Uponsuccessfulcompletionofthecourse,thestudentwillbeableto:		**Cognitive Level**
CO1	Whatpedagogicalpracticesarebeingusedbyteachersinformalandinformalclassroomsindevelopingcountries?	K1
CO2	What is the evidence on the effectiveness of these pedagogicalpractices,inwhatconditions,andwithwhatpopulationoflearners?	K1
CO3	Howcanteachereducation(curriculumandpracticum)andtheschoolcurriculumandguidancematerialsbestsupport effectivepedagogy?	K1

K1-Remembering,K2-Understanding,K3-Applying,K4-Analyzing,K5-Evaluating,K6-Creating

ContributionofCourseOutcomestowardsachievementofProgramOutcomes(1– Low, 2-Medium, 3 – High)

CO	PO1	PO2	PO3
CO1	-	2	3
CO2	2	3	2
CO3	-	2	3

COURSE CONTENT:

UNIT–I:

IntroductionandMethodology: Aimsandrationale,Policybackground,Conceptualframeworkandterminology,Theoriesoflearning,Curriculum,Teachereducation,Conceptualframework,Researchquestions,OverviewofmethodologyandSearching.

UNIT–II:

Thematic overview: Pedagogical practices are being used by teachersin formal and informal classrooms in developing countries, Curriculum, Teachereducation.

UNIT–III:

Evidenceontheeffectivenessofpedagogicalpractices: Methodology for the in depth stage: quality assessment of included studies, Howcan teacher education (curriculum and practicum) and the school curriculumandguidancematerialsbestsupporteffectivepedagogy,Theoryofchange,Strength and nature of the body of evidence for effective pedagogical practices,Pedagogictheoryandpedagogicalapproaches,Teachers'attitudesandbeliefs andPedagogicstrategies.

UNIT–IV:

Professional development: Alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: limited resources and large class sizes

UNIT–V:

Research gaps and future directions: Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

TextBooks:

1. ClassroominteractioninKenyanprimaryschools,AckersJ,HardmanF,Compare,31(2):245-261,2001
2. Curricularreforminschools:Theimportanceofevaluation,AgrawalM,JournalofCurriculumStudies,36(3):361-379,2004

ReferenceBooks:

1. Teacher training in Ghana: does it count? Multi-site teacher educationresearch project (MUSTER) country report 1, Akyeampong K, London:DFID,2003.

II Semester

PERSONALITYDEVELOPMENTTHROUGH LIFEENLIGHTENMENTSKILLS

CourseCategory	Audit Course	**CourseCode**	
CourseType	Theory	**L-T-P-C**	2-0-0-0
Prerequisites		**Continuous Internal AssessmentSemesterEndExamination TotalMarks**	40 60 100

COURSEOBJECTIVES	
1	Tolearntoachievethehighestgoalhappily
2	To become a person with stable mind, pleasing personality anddetermination
3	Toawakenwisdominstudents

COURSEOUTCOMES		
Uponsuccessfulcompletionofthecourse,thestudentwillbeableto:		**Cognitive Level**
CO1	Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life	K2
CO2	The person who has studied Geeta will lead the nation and mankind to peace and prosperity	K3
CO3	Study of Neetishatakam will help in developing versatile personality of students.	K5

K1-Remembering,K2-Understanding,K3-Applying,K4-Analyzing,K5-Evaluating,K6-Creating

CO	PO1	PO2	PO3
CO1	2	2	3
CO2	2	2	2
CO3	2	-	3

COURSE CONTENT:

UNIT–I:

Neetisatakam-Holisticdevelopmentofpersonality,Verses-19,20,21,22(wisdom),Verses-29,31,32(pride&heroism),Verses-26,28,63,65(virtue), Verses-52,53,59(don'ts),Verses-71,73,75,78(do's)

UNIT–II:

Approachtodaytodayworkandduties.ShrimadBhagwadGeeta:Chapter2-Verses41,47,48

UNIT–III:

Chapter3-Verses13,21,27,35,Chapter6-Verses5,13,17,23,35, Chapter18-Verses45,46,48

UNIT–IV:Statementsofbasicknowledge.

ShrimadBhagwadGeeta:Chapter2-Verses56,62,68
Chapter12-Verses13,14,15,16,17,18

UNIT–V:

PersonalityofRolemodel.ShrimadBhagwadGeeta:Chapter2-Verses17,Chapter3-Verses36,37,42,
Chapter4-Verses18,38,39
Chapter18–Verses37,38,63

TextBooks:

1. Srimad Bhagavad Gita, Swami Swarupananda Advaita Ashram(PublicationDepartment),Kolkata
2. Bhartrihari'sThreeSatakam(Niti-sringar-vairagya),P.Gopinath

ReferenceBooks:

1. RashtriyaSanskritSansthanam,NewDelhi.

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DEPARTMENT ELECTRICAL AND ELECTRONICS ENGINEERING

III Semester

BATTERY AND ENERGY STORAGE SYSTEMS
(Program Elective-V)

Course Category	Program Elective – V	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Basic knowledge battery and energy Storage systems.	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To know the Various storage requirements of energy
2	To Know Performance Modeling of Lithium-ion Batteries
3	To Know the Battery State Estimation
4	To Know the Charging Control Technologies for Lithium-ion Batteries
5	To Know the Battery Management Systems.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive level**
CO1	Understand the Various storage requirements of energy	K2
CO2	Analysis the Performance Modeling of Lithium-ion Batteries	K4
CO3	Analyze the Battery State Estimation	K4
CO4	Understand the Charging Control Technologies for Lithium-ion Batteries	K2
CO5	Understand the Battery Management Systems.	K2

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	3	2	1
CO2	2	3	2	1
CO3	2	3	2	1
CO4	2	3	2	2
CO5	2	3	2	2

COURSE CONTENT	
UNIT I	**Storage Requirements:** Introduction, Domains of application for energy storage- Review of storage requirements and appropriate technologies, Definitions and Measuring Methods-Terminology-Definitions of characteristics -States of batteries, Practical Examples Using Electrochemical Storage-Starter currents for internal combustion engines in cars-Power required by a telecommunications transceiver in an isolated site-House in an isolated site-Currents in an operational electric car battery, Currents during the phase of recharging of batteries in electric cars-Autonomous urban lighting-Numerical Examples.
UNIT II	**Performance Modeling of Lithium-ion Batteries:** Reaction Mechanism of Li- ion Batteries, Testing the Characteristics of Li-ion Batteries-Rate Discharge Characteristics- Charge and Discharge Characteristics Under Operating Conditions- Impact of Temperature on Capacity-Self-Discharge, Battery Modeling Methods-Equivalent Circuit Model-Electrochemical Model- Neural Network Model, Model Parameters Identification Principle, Implementation Steps of Parameter Identification, Comparison of Simulation of Three Equivalent Circuit Models, Battery modeling- Thevenin Model of Series Battery pack-Flow chart of simulation of series battery pack.
UNIT III	**Battery State Estimation:** Definition of SOC-The Maximum Available Capacity-Definition of Single Cell SOC-Definition of the SOC of Series Batteries, Estimation of the SOC of a Battery-Load Voltage Detection- Electromotive Force Method-Resistance Method-Ampere-hour Counting Method-Kalman Filter Method-Neural Network Method-Adaptive Neuro-Fuzzy Inference System-Support Vector Machines.
UNIT IV	**Charging Control Technologies for Lithium-ion Batteries:** Development of Charging Modes, Present Charging Methodologies-Demerits, Key Indicators for Measuring Charging Characteristics-Charge Capacity- Charging Efficiency-Charging Time, Charging External Characteristic Parameters, Analysis of Charging Polarization Voltage Characteristics- Calculation of Polarization Voltage-Analysis of Charging Polarization in the Time Domain-SOC Domain, Impact of Different SOCs and DODs, Improvements of the Constant Current and Constant Voltage(CCCV) Method- Key Process Parameters-Charging Process-Optimization Strategy for the CCCV Charging.
UNIT V	**Battery Management Systems:** Functions of BMS-Architecture of BMS, Design of Battery Parameters Measurement Module-Cell Voltage-Current Total Voltage-Insulation- Measurement, Equalization Management Circuit-Energy Non-Dissipative Type-Energy Dissipative Type, Data Communication-CAN Communication- New Communication Mode, Logic and Safety Control-Power-Up Control- Charge Control-Temperature Control-Fault Alarm and Control, Testing the Stability of the BMS, Practical Example of BMS.

TEXT BOOKS	
1.	San Ping Jiang Fundamentals and Application of Lithium-ion Battery Management in Electric Drive Vehicles-Wiley (2015) .
2.	Christian Glaize, Sylvie Geniès, "Lithium Batteries and Other Electrochemical Storage Systems", ISTE & John Wiley, 2013

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DEPARTMENT ELECTRICAL AND ELECTRONICS ENGINEERING

III Semester

ENERGY AUDITING, CONSERVATION AND MANAGEMENT (Program Elective-V)

Course Category	Program Elective – V	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Concepts of utilization of electrical energy, electrical machines and electrical measurements	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To learn principle of energy.
2	To learn management for industries and utilities for buildings.
3	To study the energy efficient motors and lighting.
4	To learn power factor improvement methods and operation of different energy instruments.
5	To compute depreciation methods of equipment for energy saving.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive level**
CO1	Perform energy audit in different organizations	K5
CO2	Perform management for industries and utilities for buildings	K5
CO3	Recommend energy efficient motors and design good lighting system.	K5
CO4	Understand advantages to improve the power factor.	K2
CO5	Evaluate the depreciation of equipment	K5

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	3	1	1
CO2	2	3	1	1
CO3	2	3	1	1
CO4	2	3	1	1
CO5	1	3	1	1

COURSE CONTENT	
UNIT I	**Basic Principles of Energy Audit** Energy audit- definitions, concept , types of audit, energy index, cost index ,pie charts, Sankey diagrams and load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit of process industry, thermal power station, building energy audit.

UNIT II	**Energy Management** Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting. Energy manger, qualities and functions, language, Questionnaire – check list for top management
UNIT III	**Energy Efficient Motors and Lighting** Energy efficient motors, factors affecting efficiency, loss distribution, constructional details, characteristics – variable speed, variable duty cycle systems, RMS hp- voltage variation-voltage unbalance-over motoring-motor energy audit. Good lighting system design and practice, lighting control, lighting energy audit
UNIT IV	**Power Factor Improvement and energy instruments** Power factor – methods of improvement, location of capacitors, Power factor with non-linear loads, effect of harmonics on p.f. p.f motor controllers – Energy Instruments- watt meter, data loggers, thermocouples, pyrometers, lux meters, tongue testers, application of PLC's
UNIT V	**Economic Aspects and their computation** Economics Analysis depreciation Methods, time value of money, rate of return, present worth method, replacement analysis, lifecycle costing analysis – Energy efficient motors. Calculation of simple payback method, net present value method- Power factor correction, lighting – Applications of life cycle costing analysis, return on investment.

TEXT BOOKS	
1.	Energy management by W.R.Murphy & G.Mckay Butter worth, Heinemann publications
2.	Energy efficient electric motors by John.C.Andreas, Marcel Dekker Inc Ltd-2nd edition,1995
3.	Energy management by Paul o' Callaghan, Mc-graw Hill Book company-1st edition, 1998
REFERENCE BOOKS	
1.	Energy management hand book by W.CTurner, John wiley and sons
2.	Energy management and good lighting practice : fuel efficiency- booklet12-EEO
WEB RESOURCES	
1.	ttps://pdhonline.com/courses/e144/e144content.pdf
2.	https://beeindia.gov.in/sites/default/files/1Ch3.pdf
3.	https://www.researchgate.net/publication/309463130_Energy_Audit_Management

PRAGATI ENGINEERING COLLEGE: SURAMPALEM

R24

(Autonomous)

DEPARTMENT ELECTRICAL AND ELECTRONICS ENGINEERING

III Semester

HVDC Transmission (Program Elective-V)

Course Category	Program Elective-V	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Knowledge on Power Electronics, Power Systems and High Voltage Engineering	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To learn various schemes of HVDC transmission.
2	To learn about the basic HVDC transmission equipment.
3	To learn the control of HVDC systems.
4	To be exposed to the interaction between HVAC and HVDC system.
5	To be exposed to the various protection schemes of HVDC engineering

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive level**
CO1	Understand the various schemes of HVDC transmission.	K4
CO2	Understand the basic HVDC transmission equipment.	K4
CO3	Understand the control of HVDC systems.	K4
CO4	Understand the interaction between HVAC and HVDC system.	K4
CO5	Understand the various protection schemes of HVDC engineering.	K4

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PSO1**
CO1	2	2	2	1
CO2	2	2	2	1
CO3	2	2	2	1
CO4	2	2	2	1
CO5	2	2	2	1

COURSE CONTENT	
UNIT I	**Introduction:** Introduction to HVDC transmission, Comparison between HVAC and HVDC systems, economic technical and reliability aspects, limitations, types of HVDC links, mono-polar, bipolar and homo-polar links, Components of HVDC transmission system.
UNIT II	**Static power converters:**

	Basic conversion principles, 6-pulse bridge circuit and analysis with and without overlapping , rectifier and inverter operation, equivalent circuit of converter and HVDC links, special features of converter transformers, waveforms, factors responsible for generation of harmonics, voltage and current harmonics, effect on variation of α and μ, Filters and harmonic elimination.
UNIT III	**Control of HVDC converters and systems:** Design features of HVDC system control, constant current, constant extinction angle and constant ignition angle control, individual phase control and equidistant firing angle control, DC power flow control, starting and stopping HVDC link, reversal of power in HVDC link.
UNIT IV	**Interaction between HVAC and DC systems:** Voltage interaction, dynamic stabilization of AC systems, harmonic instability problems and DC power modulation.-Multi terminal DC links and systems: Series, parallel and series-parallel systems, their operation and control.
UNIT V	**Transient over voltages in HVDC systems:** Over voltages due to disturbances on DC side, over voltages due to DC and AC side line faults. **Converter faults and protection in HVDC systems:** Converter faults, over current protection, valve group and DC line protection, DC circuit breakers, over voltage protection of converters, surge arresters.

TEXT BOOKS	
1.	S Kamakshaih and V Kamaraju:HVDC Transmission- MG hill.
2.	K.R.Padiyar : High Voltage Direct current Transmission, Wiley Eastern Ltd., New Delhi– 1992.
3.	E.W. Kimbark : Direct current Transmission, Wiley Inter Science – New York.
REFERENCE BOOKS	
1.	J.Arillaga : H.V.D.C. Transmission Peter Peregrinus ltd., London UK 1983
2.	Vijay K Sood :HVDC and FACTS controllers :Applications of static converters in power systems by, Kluwer Academic Press.
WEB RESOURCES	
1.	http://nptel.ac.in/courses/108104013/
2.	https://lecturenotes.in/subject/115/high-voltage-dc-transmission-hvdc
3.	https://drive.google.com/file/d/127RGZtGH3EtxlVaqZjeihj2M_vb7zmPY/view

III Semester

PRAGATI ENGINEERING COLLEGE: SURAMPALEM

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DEPARTMENT ELECTRICAL AND ELECTRONICS ENGINEERING

FUNDAMENTALS OF ELECTRIC VEHICLES (Open Elective)(CSE,ECE,ME)

Course Category	**Open Elective**	**Course Code**	
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Knowledge of Electric vehicles fundamentals.	**Internal Assessment** **Semester End Examination** **Total Marks**	40 60 100

COURSE OBJECTIVES	
1	To familiarize the students with the need and advantages of electric and hybrid electric vehicles.
2	To understand various power converters used in electric vehicles.
3	To understand various power converters used in electric vehicles.
4	To be familiar all the different types of motors suitable for electric vehicles.
5	To have knowledge on latest developments in strategies and other storage systems.

COURSE OUTCOMES		**Cognitive level**
Upon successful completion of the course, the student will be able to:		
CO1	To have knowledge on latest developments in strategies and other storage systems.	K3
CO2	Select suitable power converters for EV applications.	K2
CO3	Design HEV configuration for a specific application.	K4
CO4	Choose an effective method for EV and HEV applications.	K3
CO5	Analyze a battery management system for EV and HEV	K4

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 – Medium, 3 – High)

	PO1	**PO2**	**PO3**
CO1	2	2	3
CO2	2	2	3
CO3	2	2	3
CO4	2	2	3
CO5	2	2	3

COURSE CONTENT	
UNIT I	**Introduction** Fundamentals of vehicles - Components of conventional vehicles - drawbacks of conventional vehicles – Need for electric vehicles - History of Electric Vehicles – Types of Electric Vehicles – Advantages and applications of Electric Vehicles.
UNIT II	**Components of Electric Vehicles:** Main components of Electric Vehicles – Power Converters - Controller and Electric Traction Motor – Rectifiers used in EVs – Bidirectional DC–DC Converters – Voltage Source Inverters – PWM inverters used in EVs.

UNIT III	**Hybrid Electric Vehicles:** Evolution of Hybrid Electric Vehicles – Advantages and Applications of Hybrid Electric Vehicles – Architecture of HEVs - Series and Parallel HEVs – Complex HEVs – Range extended HEVs – Examples - Merits and Demerits.
UNIT IV	**Motors for Electric Vehicles:** Characteristics of traction drive - requirements of electric machines for EVs – Different motors suitable for Electric and Hybrid Vehicles – Induction Motors – Synchronous Motors – Permanent Magnetic Synchronous Motors – Brushless DC Motors – Switched Reluctance Motors (Construction details and working only)
UNIT V	**Energy Sources for Electric Vehicles:** Batteries - Types of Batteries – Lithium-ion - Nickel-metal hydride - Lead-acid – Comparison of Batteries - Battery Management System – Ultra capacitors – Flywheels – Fuel Cell – it's working.

TEXT BOOKS

1	Iqbal Hussein - Electric and Hybrid Vehicles: Design Fundamentals - CRC Press - 2021.
2	Denton - Tom. Electric and hybrid vehicles. Rutledge - 2020.
REFERENCE BOOKS	
1	Kumar - L. Ashok - and S. Albert Alexander. Power Converters for Electric Vehicles. CRC Press - 2020.
2	Chau - Kwok Tong. Electric vehicle machines and drives: design - Analysis and Application. John Wiley & Sons - 2015.
3	Berg - Helena. Batteries for electric vehicles: materials and electrochemistry. Cambridge university press - 2015
WEB RESOURCES (Suggested)	
1	https://nptel.ac.in/courses/108106170
2	https://inverted.in/blog/fundamentals-of-electric-vehicles