

K.S.Rangasamy College of Technology

(Autonomous)



CURRICULUM AND SYLLABI

FOR

M.E. Power Systems Engineering

(For the batch admitted in 2022 – 2023)

R 2022

**Courses Accredited by NAAC A++ Grade,
Approved by AICTE, Affiliated to Anna University, Chennai.**

**KSR Kalvi Nagar, Tiruchengode – 637 215.
Namakkal District, Tamil Nadu, India.**

Department of Electrical and Electronics Engineering

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023

BoS Chairman Signature

VISION

To become a leader in providing education and training in the field of Electrical and Electronics Engineering to the aspiring graduates to be competent in their profession.

MISSION

- To enable graduates to acquire knowledge and skills necessary for employment and continued advancement in the field of Electrical and Electronics Engineering
- To engage in applied research in emerging technologies and provide professional services

Program Educational Objectives (PEOs) for M.E.(PSE) Programme

PEO 1:

Our graduates are professionally competent to carryout innovative research in power systems engineering and its related fields.

PEO 2:

Our graduates provide optimum solutions to the challenging problems in power and energy sectors with social and ethical responsibility.

PEO 3:

Our graduates adapt to evolving technologies and ability to work in collaborative, multidisciplinary tasks in their profession.

PROGRAMME OUTCOMES (POs)

Engineering Graduates will be able to:

PO1:

Independently carry out research/investigation and projects to solve real time problems.

PO2:

Write, present and publish technical articles in refereed international/national conferences and journals.

PO3:

Develop the skill to demonstrate a degree of mastery in the area of power systems.

PO4:

Attain professional ethics and intellectual integrity to contribute to the community for sustainable development of the society

PO5:

Apply knowledge of basic science and engineering in analysis and modeling of the power system components

PO6:

Implement cost effective and cutting edge technologies in power system

MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) WITH PROGRAMME OUTCOMES (POs)

The M.E. Power Systems Engineering Programme outcomes leading to the achievement of the objectives are summarized in the following Table.

Programme Educational Objectives	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
PEO1	3	3	3	2	3	3
PEO2	3	3	3	2	3	3
PEO3	3	3	3	3	3	3

Contributions: 1- Low, 2- Medium, 3- High

MAPPING- M.E – POWER SYSTEMS ENGINEERING

Year	Sem	Course Name	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
I	I	Applied Mathematics for Power Systems Engineers	3	2	2	2.6	3	2.4	3	3
		Computer Aided Power System Analysis	3	3	3	3	3	3	3	3
		Advanced Power System Operation and Control	3	3	3	2	3	2.8	3	3
		System Theory	3	2	2	2	2	2	2	2
		Analysis of Power Converters	3	3	3	2	3	2.8	3	3
		Research Methodology and IPR	3	3	2	2	2	2	3	3
		Power System Laboratory - I	3	3	3	2	3	3	3	3
		Power Converters Laboratory	3	3	3	2	3	3	3	3
I	II	Advanced Power System Protection	3	3	3	2.6	2.6	2.4	3	3
		Power System Dynamics								
		Power System Transients	3	3	2.8	2.6	2.6	2.6	3	3
		Restructured Power System	3	2	3	3	3	3	3	3
		Power System Laboratory –II	3	3	3	2	3	3	3	3
II	III	HVDC and FACTS	3	0.7	0.7	0.6	0.5	0.4	3	3

Credit Distribution for M.E (PSE) Programme – 2022 –2023 Batch

S.No.	Category	Credits Per Semester				Total Credits	Percentage %
		I	II	III	IV		
1.	HS	4				4	5.55
2.	PC	20	15	3		36	50
3.	PE		6	6		12	16.66
4.	CGS			6	12	20	27.77
5.	AC	ACI	ACII				
Total		24	21	15	12	72	100

HS – HUMANITIES AND SOCIAL SCIENCES

PC - PROFESSIONAL CORE

PE – PROFESSIONAL ELECTIVES

CGS – CAREER GUIDANCE COURSES

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

PROFESSIONAL CORE (PC)

S. No.	Course Code	Course Title	Category	CP	L	T	P	C	Prerequisite
1.	60 PPS 101	Computer Aided Power System Analysis	PC	5	3	2	0	4	Generation Transmission and Distribution, Power system analysis
2.	60 PPS 102	Advanced Power System Operation and Control	PC	3	3	0	0	3	Generation Transmission and Distribution, Power System Analysis, Power System Operation and Control
3.	61 PPS 103	System Theory	PC	3	3	0	0	3	Control system
4.	60 PPS 104	Analysis of Power Converters	PC	3	3	0	0	3	Basic knowledge on semiconductors and analog electronics, Power Electronics
5.	60 PED 001	Research Methodology and IPR	PC	3	3	0	0	3	Nil
6.	60 PPS 201	Advanced Power System Protection	PC	3	3	0	0	3	Power System Protection and Switchgear
7.	60 PPS 202	Power System Dynamics	PC	5	3	2	0	4	Power system operation and control
8.	60 PPS 203	Power System Transients	PC	3	3	0	0	3	Power System Analysis
9.	60 PPS 204	Restructured Power System	PC	3	3	0	0	3	Generation, Transmission and Distribution, Power System Analysis, Power System Operation and Control.
10.	60 PPS 301	HVDC and FACTS	PC	3	3	0	0	3	Power electronics, power systems
11.	60 PPS 1P1	Power System Laboratory - I	PC	4	0	0	4	2	Nil
12.	60 PPS 1P2	Power Converters Laboratory	PC	4	0	0	4	2	Nil
13.	60 PPS 2P1	Power System Laboratory – II	PC	4	0	0	4	2	Nil

PROFESSIONAL ELECTIVE (PE) SEMESTER II, PROFESSIONAL ELECTIVE I

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	60 PPS E11	Distributed Energy Resources and Microgrid	PE	3	3	0	0	3
2.	60 PPS E12	Optimization Techniques to Power System Engineering	PE	3	3	0	0	3
3.	60 PPS E13	Wind Energy Conversion System Design	PE	3	3	0	0	3
4.	60 PPS E14	IoT for Smart Systems	PE	3	3	0	0	3
5.	60 PPS E15	High Voltage Technology	PE	3	3	0	0	3
6.	60 PPS E16	Power System State Estimation and Security Analysis	PE	3	0	0	0	3

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

SEMESTER II, PROFESSIONAL ELECTIVE II

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	60 PPS E21	Power Quality Engineering	PE	3	3	0	0	3
2.	60 PPS E22	Solar and Energy Storage Systems	PE	3	3	0	0	3
3.	60 PPS E23	PWM Techniques and its Applications	PE	3	3	0	0	3
4.	60 PPS E24	EHV AC Transmission	PE	3	3	0	0	3
5.	60 PPS E25	Machine Learning and Deep Learning System	PE	3	3	0	0	3
6.	60 PPS E26	Electrical Power Distribution System	PE	3	3	0	0	3

SEMESTER III, PROFESSIONAL ELECTIVE III

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	60 PPS E31	Power System Reliability	PE	3	3	0	0	3
2.	60 PPS E32	Electromagnetic Interference and Compatibility in System Design	PE	3	3	0	0	3
3.	60 PPS E33	Industrial Power System Analysis and Design	PE	3	3	0	0	3
4.	60 PPS E34	Advanced Power System Dynamics	PE	3	3	0	0	3
5.	60 PPS E35	Python Programming for Machine Learning	PE	3	3	0	0	3
6.	60 PPS E36	Renewable Energy and Grid Integration	PE	3	3	0	0	3

SEMESTER III, PROFESSIONAL ELECTIVE IV

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	60 PPS E41	Computer Relaying and Wide Area Measurement Systems	PE	3	3	0	0	3
2.	60 PPS E42	Energy Management in Power Systems	PE	3	3	0	0	3
3.	60 PPS E43	Power System Instrumentation	PE	3	3	0	0	3
4.	60 PPS E44	Smart Grid	PE	3	3	0	0	3
5.	60 PPS E45	Electric Vehicles and Power Management	PE	3	3	0	0	3
6.	60 PPS E46	Digital Controllers in Power Electronics Applications	PE	3	3	0	0	3

CAREER GUIDANCE COURSES (CGS)

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	60 PPS 2P2	Technical Seminar / Mini Project	CGS	4	0	0	4	0
2.	60 PPS 3P1	Project Work I	CGS	12	0	0	12	6
3.	60 PPS 4P1	Project Work II	CGS	24	0	0	24	12

AUDIT COURSE(AC)

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	60 PAC 001	English for Research Paper Writing	AC	2	2	0	0	0
2.	60 PAC 002	Disaster Management	AC	2	2	0	0	0
3.	60 PAC 003	Constitution of India	AC	2	2	0	0	0

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

K.S.RANGASAMY COLLEGE OF TECHNOLOGY, TIRUCHENGODE -637215**(An Autonomous Institution affiliated to Anna University)****COURSES OF STUDY****(For the candidates admitted from 2022-2023 onwards)****SEMESTER I**

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1.	60 PPS 001	Applied Mathematics for Power Systems Engineers	HS	5	3	2	0	4
2.	60 PPS 101	Computer Aided Power System Analysis	PC	5	3	2	0	4
3.	60 PPS 102	Advanced Power System Operation and Control	PC	3	3	0	0	3
4.	61 PPS 103	System Theory	PC	3	3	0	0	3
5.	60 PPS 104	Analysis of Power Converters	PC	3	3	0	0	3
6.	60 PED 001	Research Methodology and IPR	PC	3	3	0	0	3
7.	60 PAC 001	English for Research Paper Writing	AC	2	2	0	0	0
PRACTICALS								
8.	60 PPS 1P1	Power System Laboratory - I	PC	4	0	0	4	2
9.	60 PPS 1P2	Power Converters Laboratory	PC	4	0	0	4	2
TOTAL				32	20	4	8	24

SEMESTER II

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1.	60 PPS 201	Advanced Power System Protection	PC	3	3	0	0	3
2.	60 PPS 202	Power System Dynamics	PC	5	3	2	0	4
3.	60 PPS 203	Power System Transients	PC	3	3	0	0	3
4.	60 PPS 204	Restructured Power System	PC	3	3	0	0	3
5.	60 PPS E1*	Professional Elective I	PE	3	3	0	0	3
6.	60 PPS E2*	Professional Elective II	PE	3	3	0	0	3
7.	60 PAC 002	Disaster Management	AC	2	2	0	0	0
PRACTICALS								
8.	60 PPS 2P1	Power System Laboratory – II	PC	4	0	0	4	2
9.	60 PPS 2P2	Technical Seminar / Mini Project	CGS	4	0	0	4	0
TOTAL				30	20	2	8	21

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

K.S.RANGASAMY COLLEGE OF TECHNOLOGY, TIRUCHENGODE -637215**(An Autonomous Institution affiliated to Anna University)****COURSES OF STUDY****(For the candidates admitted from 2022-2023 onwards)****SEMESTER III**

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1.	60 PPS 301	HVDC and FACTS	PC	3	3	0	0	3
2.	60 PPS E3*	Professional Elective III	PE	3	3	0	0	3
3.	60 PPS E4*	Professional Elective IV	PE	3	3	0	0	3
PRACTICALS								
4.	60 PPS 3P1	Project Work I	CGS	12	0	0	12	6
TOTAL				21	9	0	12	15

SEMESTER IV

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1.	60 PPS 4P1	Project Work II	CGS	24	0	0	24	12
TOTAL				24	0	0	24	12

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE: 72

Note: HS- Humanities and Social Sciences including Management Courses, BS- Basic Science Courses, ES-Engineering Science Courses, PE-Professional Core Courses, PE-Professional Elective Courses, GE- General Elective Courses, OE- Open Elective Courses, CGS-Career Guidance Courses, AC- Audit Courses & MC- Mandatory Courses.

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

K.S.RANGASAMY COLLEGE OF TECHNOLOGY, TIRUCHENGODE - 637215

(An Autonomous Institution affiliated to Anna University)

M.E./M.Tech. Degree Programme

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2022-2023 onwards)

FIRST SEMESTER

S.No.	Course Code	Name of the Course	Duration of Internal Exam	Weightage of Marks			Minimum Marks for Pass in End Semester Exam	
				CA *	ESE**	Max. Marks	End Semester Exam	Total
THEORY								
1	60 PPS 001	Applied Mathematics for Power Systems Engineers	2	40	60	100	45	100
2	60 PPS 101	Computer Aided Power System Analysis	2	40	60	100	45	100
3	60 PPS 102	Advanced Power System Operation and Control	2	40	60	100	45	100
4	61 PPS 103	System Theory	2	40	60	100	45	100
5	60 PPS 104	Analysis of Power Converters	2	40	60	100	45	100
6	60 PED 001	Research Methodology and IPR	2	40	60	100	45	100
7	60 PAC 001	English for Research Paper Writing	2	100	-	100	0	100
PRACTICAL								
7	60 PPS 1P1	Power System Laboratory - I	3	60	40	100	45	100
8	60 PPS 1P2	Power Converters Laboratory	3	60	40	100	45	100

*CA evaluation pattern will differ from course to course and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern.

** End Semester Examination will be conducted for maximum marks of 100 and subsequently be reduced to 60 marks for the award of terminal examination marks

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

60 PPS 001	Applied Mathematics for Power Systems Engineers
-------------------	--

Category	L	T	P	Credit
HS	3	2	0	4

Objective

- To develop the mathematical skills in matrix Theory.
- To understand the basic concepts of Laplace Transforms Techniques.
- To familiarize the concepts of Fourier series.
- To comprehend the concepts of Linear Programming Problems.
- To impart the knowledge about Non-Linear Programming Problems.

Prerequisite

NIL

Course Outcomes

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

CO1	Develop the ability to apply the concepts of matrix theory.	Remember, Understand, Apply
CO2	Solve the partial differential equations using Laplace transforms techniques.	Remember, Apply
CO3	Apply the Fourier series concepts to solve real world engineering problems.	Remember, Apply
CO4	Analyze the various methods in linear programming techniques.	Remember, Understand, Analyze
CO5	Find the solution of non-linear programming problems.	Remember, Understand, Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	3	2
CO2	3	2	2	3	3	2
CO3	3	2	2	3	3	2
CO4	3	2	2	2	3	3
CO5	3	2	2	2	3	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		End Semester Examination (Marks)
	1	2	
Remember (Re)	10	10	10
Understand (Un)	10	10	20
Apply (Ap)	40	20	40
Analyze (An)	0	20	30
Evaluate (Ev)	0	0	0
Create (Cr)	0	0	0

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

K.S.Rangasamy College of Technology – Autonomous R2022								
60 PPS 001 - Applied Mathematics for Power Systems Engineers								
ME – Power Systems Engineering								
Semester	Hours/Week			Total hrs	Credit	MaximumMarks		
	L	T	P		C	CA	ES	Total
I	3	2	0	60	4	40	60	100
Matrix Theory The Cholesky decomposition -Generalized Eigen vectors- Canonical basis- Q R factorization- Singular Value decomposition – Pseudo inverses.								9
Laplace Transform Techniques for Partial Differential Equations Definitions - Properties - Transform error function - Bessel's function - Dirac Delta function - Unit step function - Convolution theorem - Inverse Laplace transform - Complex inversion formula - Solutions to partial differential equations: Heat and Wave equations.								9
Fourier Series Fourier Trigonometric series: Periodic function as power signals - Convergence of series - Even and odd functions: Cosine and sine series - Non periodic function - Extension to other intervals - Power signals: Exponential Fourier series – Parseval's theorem and power spectrum – Eigen value problems and orthogonal functions - Regular Sturm –Liouville systems - Generalized Fourier series.								9
Linear Programming Problems Graphical solution - Simplex method - Big M method – Duality in LPP and Dual Simplex method -Transportation and Assignment models.								9
Non – Linear Programming Problems Lagrange multipliers – Equality constraints – Inequality constraints – Kuhn – Tucker Conditions – Quadratic programming.								9
Total Hours: 45 + 15(Tutorial)								60
Textbook(s):								
1.	Richard Bronson,“Matrix Operation”,Schaum's outline series, Second Edition, McGraw Hill, New Delhi, 2011.							
2.	H.A.Taha, “Operation Research”, Pearson Education,10 th Edition,2017.							
Reference(s):								
1.	K. Sankara Rao, “Introduction to Partial Differential Equations”, Prentice Hall of India Pvt. Ltd, New Delhi, 1997.							
2.	L.C. Andrews, R.L. Phillips, “Mathematical Techniques for Engineers and Scientists”, Prentice Hall, New Delhi, 2005.							
3.	Sundaresan V, Ganapathy Subramanian K S, and Ganesan K, “Operations Research”, A.R. Publications, Chennai.							
4.	Prof. G. Srinivasan, “Introduction to Operations Research” – NPTEL online video course.							

Course Contents and Lecture Schedule

S.No.	Topic	No. of Hours
1	Matrix Theory	
1.1	The Cholesky decomposition	2
1.2	Generalized Eigen vectors	1
1.3	Canonical basis	1
1.4	Tutorial	2
1.5	Q R factorization	1
1.6	Singular Value decomposition	2
1.7	Pseudo inverses	1
1.8	Tutorial	2
2	Laplace Transform Techniques for Partial Differential Equations	
2.1	Definitions – Properties, Transform error function	1
2.2	Bessel's function	1
2.3	Dirac Delta function	1
2.4	Unit step function	1
2.5	Tutorial	2
2.6	Convolution theorem	1
2.7	Inverse Laplace transform	1
2.8	Complex inversion formula	1
2.9	Solutions to partial differential equations: Heat and Wave equations.	1
2.10	Tutorial	2
3	Fourier Series	
3.1	Fourier Trigonometric series: Periodic function as power signals	1
3.2	Convergence of series, Even and odd functions	1
3.3	Cosine and sine series	1
3.4	Tutorial	2
3.5	Non periodic function - Extension to other intervals	1
3.6	Power signals: Exponential Fourier series	1
3.7	Parseval's theorem and power spectrum	1
3.8	Eigen value problems and orthogonal functions	1
3.9	Regular Sturm –Liouville systems - Generalized Fourier series.	1
3.10	Tutorial	2
4	Linear Programming Problems	
4.1	Graphical solution	1
4.2	Simplex method	1
4.3	Big M method	2
4.4	Duality in LPP and Dual Simplex method	1
4.5	Tutorial	2
4.6	Transportation - IBFS	1
4.7	Transportation – Optimal Solutions	1
4.8	Assignment models	1
4.9	Tutorial	2
5	Non – Linear Programming Problems	
5.1	Lagrange multipliers	2
5.2	Equality constraints	2
5.3	Tutorial	2
5.4	Inequality constraints	2
5.5	Kuhn – Tucker Conditions	2
5.6	Tutorial	2
	Total	60

Dr.N.UTHARASAMY - uthrasamy@ksrct.ac.in

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

60 PPS 101	Computer Aided Power System Analysis
-------------------	---

Category	L	T	P	Credit
PC	3	2	0	4

Objective

- To solve large-scale power systems.
- To impart in-depth knowledge of different power flow solution methods for large power system networks.
- To perform various optimal power flow methods involving operating and security constraints.
- To perform short circuit fault analysis for various fault conditions on a three phase basis.
- To illustrate different numerical integration methods and factors influencing transient stability.

Prerequisite

Generation Transmission and Distribution, Power system analysis

Course Outcomes

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

CO1	Analyze large scale simultaneous linear equations and the ordering schemes for preserving sparsity	Apply
CO2	Ability to solve large scale power flow problems	Apply
CO3	Analyze to solve optimal power flow problem using various solution methods	Analyze
CO4	Analyze to do fault calculations for various fault conditions on three phase basis	Analyze
CO5	Analyze the stability studies under various disturbances using numerical integration methods.	Analyze

Mapping with Program Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		End Sem Examination (Marks)
	1	2	
Remember	10	10	10
Understand	10	10	20
Apply	20	20	30
Analyse	20	20	40
Evaluate	0	0	0
Create	0	0	0

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

K.S.Rangasamy College of Technology – Autonomous R2022								
60 PPS 101- Computer Aided Power System Analysis								
M.E. Power Systems Engineering								
Semester	Hours / Week			Total hrs	Credit	Maximum Marks		
	L	T	P			CA	ES	Total
I	3	2	0	60	4	40	60	100
SOLUTION TECHNIQUE Sparse Matrix techniques for large scale power systems - Optimal ordering schemes for preserving sparsity - Flexible packed storage scheme for storing matrix as compact arrays - Factorization by Bifactorization and Gauss elimination methods - Repeat solution using Left and Right factors and L and U matrices.								[9]
POWER FLOW ANALYSIS Power flow equation in real and polar forms - Review of Newton Raphson method for solution; Adjustment of P-V buses - Review of Fast Decoupled Power Flow method - Sensitivity factors for P-V bus adjustment.								[9]
OPTIMAL POWER FLOW Problem statement - Solution of Optimal Power Flow (OPF) - The gradient method - Newton's method - Linear Sensitivity Analysis - LP methods - With real power variables only - LP method with AC power flow variables and detailed cost functions - Security constrained Optimal Power Flow - Interior point algorithm - Bus Incremental costs.								[9]
SHORT CIRCUIT ANALYSIS Formation of bus impedance matrix with mutual coupling (single phase basis and three phase basis) - Computer method for fault analysis using Z BUS and sequence components - Derivation of equations for bus voltages -fault current and line currents - both in sequence and phase - symmetrical and unsymmetrical faults.								[9]
TRANSIENT STABILITY ANALYSIS Introduction - Numerical Integration Methods - Euler and Fourth Order Runge-Kutta methods - Algorithm for simulation of SMIB and multi-machine system with classical synchronous machine model - Factors influencing transient stability - Numerical stability and implicit Integration methods.								[9]
Total Hours: 45								
Text book(s):								
1.	A. J. Wood and B. F. Wollenberg, "Power Generation Operation and Control", John Wiley and sons, New York, 2016.							
2.	M. A. Pai," Computer Techniques in Power System Analysis",Tata McGraw Hill Publishing Company Limited, New Delhi, 2006.							
Reference(s):								
1.	G W Stagg, A.H El. Abiad, "Computer Methods in Power System Analysis", McGraw Hill,1968.							
2.	P. Kundur, "Power System Stability and Control", McGraw Hill, 1994.							
3.	D. P. Kothari and I. J. Nagrath, 'Modern Power System Analysis', Fourth Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 2011.							
4.	K. Zollenkopf, "Bi-Factorization: Basic Computational Algorithm and Programming Techniques ; pp:75-96 ; Book on "Large Sparse Set of Linear Systems" Editor:J.K.Rerd, Academic Press, 1971.							

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

Course Contents and Lecture Schedule

S.No	Topic	No. of Hrs
1	SOLUTION TECHNIQUE	
1.1	Introduction to power system	1
1.2	Sparse Matrix techniques for large scale power systems	
1.3	Optimal ordering schemes for preserving sparsity	1
1.4	Flexible packed storage scheme for storing matrix as compact arrays.	1
1.5	Factorization by Bifactorization method.	1
1.6	Gauss elimination methods	1
1.7	Repeat solution using Left and Right factors and L and U matrices	1
1.8	L and U Factorization method.	1
1.9	Problems in Bifactorization method.	1
1.10	Problems Gauss elimination methods	1
2	POWER FLOW ANALYSIS	
2.1	Introduction of power flow analysis	1
2.2	Power flow equation in real and polar forms	1
2.3	Review of Newton Raphson method for solution	2
2.4	Adjustment of P-V buses in NR method	2
2.5	Review of Fast Decoupled Power Flow method	1
2.6	Problems in load flow analysis.	1
2.7	Sensitivity factors for P-V bus adjustment	1
3	OPTIMAL POWER FLOW	
3.1	Problem statement	1
3.2	Solution of Optimal Power Flow (OPF)	
3.3	The gradient method	1
3.4	Newton's method	1
3.5	Linear Sensitivity Analysis	1
3.6	LP methods With real power variables only	1
3.7	LP method with AC power flow variables and detailed cost functions	1
3.8	Security constrained Optimal Power Flow	1
3.9	Interior point algorithm.	1
3.10	Bus Incremental costs.	1
4	SHORT CIRCUIT ANALYSIS	
4.1	Formation of bus impedance matrix with mutual coupling	2
4.2	Computer method for fault analysis using Z BUS and sequence components	2
4.3	Derivation of equations for bus voltages	1
4.4	fault current and line currents	1
4.5	both in sequence and phase	1
4.6	Symmetrical and unsymmetrical faults.	1
5	TRANSIENT STABILITY ANALYSIS	1
5.1	Introduction	2
5.2	Numerical Integration Methods	
5.3	Transient problems in Euler methods	1
5.4	Transient problems in Euler and Fourth Order Runge-Kutta methods	1
5.5	Algorithm for simulation of SMIB	1
5.6	Algorithm for simulation of multi-machine system with classical synchronous machine model	1
5.7	Factors influencing transient stability	1
5.8	Numerical stability and implicit Integration methods	1
5.9	Implicit Integration methods	1
Total		45

Course Designers

Dr.T.Venkatesan - venkatesan@ksrct.ac.in

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

60 PPS 102	Advanced Power System Operation and Control	Category	L	T	P	Credit
		PC	3	0	0	3

Objective

- To gain knowledge on various power system operation and control techniques
- To familiarize to analyse the static and dynamic model of LFC
- To provide knowledge on generation scheduling and their algorithms
- To gain knowledge to differentiate economic dispatch and unit commitment problem and develop skill to determine the same
- To understand various states of power system security and provide the solutions

Prerequisite

Generation Transmission and Distribution, Power System Operation and Control

Course Outcomes

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

CO1	Explain about the operation and control of power system and List the past and present status of Indian power sector	Understand
CO2	Develop the static and dynamic model of Load Frequency Control in single and two area system	Apply
CO3	Analyze the problems associated with hydro thermal Scheduling and to construct the algorithm for feasible load management	Analyse
CO4	Determine unit commitment and economic dispatch problems in power system network and distinguish between various methods involved in them	Apply
CO5	Analyse power system security and determine the system state by various methods	Analyse

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	3	3
CO2	3	3	3	2	3	3
CO3	3	3	3	2	3	3
CO4	3	3	3	2	3	3
CO5	3	3	3	2	3	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		End Sem Examination (Marks)
	1	2	
Remember	10	10	10
Understand	10	20	30
Apply	30	20	30
Analyse	10	10	30
Evaluate	0	0	0
Create	0	0	0

K.S.Rangasamy College of Technology – Autonomous R2022								
60 PPS 102 - Advanced Power System Operation and Control								
M.E Power Systems Engineering								
Semester	Hours/Week			Total hrs	Credit	MaximumMarks		
	L	T	P		C	CA	ES	Total
I	3	0	0	45	3	40	60	100
INTRODUCTION System load variation: System load characteristics, Reserve requirements: Installed reserves, spinning reserves, cold reserves, hot reserves. Overview of system operation and Control: Load forecasting, - Method of Extrapolation – Method of Correlation – Indian power sector — Past and present status: Recent growth of power sector in India — An overview, A time line of the Indian power sector, Players in the Indian power sector, basics of power system operation and control.								[9]
LOAD FREQUENCY CONTROL Need for frequency and voltage control - Plant and system level control - modeling of LFC of single area system - static and dynamic analysis - LFC of two area system - static and dynamic analysis - Tieline bias control - development of state variable model of single and two area system – Extension of ALFC loop to Multi area systems – Application of Optimal Control concepts in ALFC – Fundamental aspects of Optimal Linear Regulator (OLR) design.								[9]
HYDROTHERMAL SCHEDULING PROBLEM Hydrothermal coordination – hydro electric plant models – short term and long term scheduling problem – gradient approach – Hydro units in series – Hydro-thermal scheduling with pumped hydro plant: Scheduling of systems using Dynamic programming and linear programming.								[9]
UNIT COMMITMENT AND ECONOMIC DISPATCH Statement of Unit commitment (UC) problem; constraints in UC: spinning reserve, thermal unit constraints, hydro constraints, fuel constraints and other constraints; UC solution methods: Priority-list methods, forward dynamic programming approach, numerical problems. Incremental cost curve, co-ordination equations without loss and with loss, solution by direct method and λ – iteration method. Gradient method – Newton's method – Base point and participation factor method. Economic dispatch controller added to LFC control.								[9]
POWER SYSTEM SECURITY Need for power system Security- Contingency analysis – linear sensitivity factors – AC power flow methods – contingency selection – concentric relaxation – bounding-security constrained optimal power flow-Interior point algorithm-Bus incremental costs - Estimation of Average and Trend, Terms of Deterministic part of Load – Estimation of Stochastic part of Load.								[9]
TotalHours								45
TextBook(s):								
1.	Abhijit Chakrabarti, Sunita Halder, “Power System Analysis Operation and Control”, PHI Learning, PVT Ltd New Delhi 2015.							
2	Robert H. Miller, James H. Malinowski, ‘Power system operation’, Tata McGraw-Hill, 2009							
Reference(s):								
1.	Allen J. Wood, Bruce F. Wollenberg, ‘Power Generation, Operation and Control’, Wiley India Edition, 2 nd Edition, 2009.							
2.	Olle. I. Elgerd, “Electric Energy Systems Theory – An Introduction”, Tata McGraw HillPublishing Company Ltd, New Delhi, Second Edition, 2003							
3.	D.P. Kothari and I.J. Nagrath, “Modern Power System Analysis”, Third Edition, Tata McGraw HillPublishing Company Limited, New Delhi, 2003.							
4.	http://nptel.ac.in/courses/108101040/ (PSOC web course)							

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

Course Contents and Lecture Schedule

S. No	Topic	#Hrs
1	INTRODUCTION	
1.1	System load variation: System load characteristics	2
1.2	Overview of system operation and Control	1
1.3	Load forecasting, - Method of Extrapolation – Method of Correlation	1
1.4	Indian power sector — Past and present status	1
1.5	Recent growth of power sector in India	1
1.6	An overview, A time line of the Indian power sector	1
1.7	Players in the Indian power sector	1
1.8	Basics of power system operation and control.	1
2	LOAD FREQUENCY CONTROL	
2.1	Need for frequency and voltage control	1
2.2	Plant and system level control	1
2.3	Modeling of LFC of single area system	1
2.4	Static and dynamic analysis	1
2.5	LFC of two area system - static and dynamic analysis	1
2.6	Tieline bias control - development of state variable model of single and two area system	1
2.7	Extension of ALFC loop to Multi area systems	1
2.8	Application of Optimal Control concepts in ALFC	1
2.9	Fundamental aspects of Optimal Linear Regulator (OLR) design	1
3	HYDROTHERMAL SCHEDULING PROBLEM	
3.1	Hydrothermal coordination	1
3.2	Hydro electric plant models	1
3.3	Short term and long term scheduling problem	1
3.4	Gradient approach	1
3.5	Hydro units in series	1
3.6	Hydro-thermal scheduling with pumped hydro plant	1
3.7	Scheduling of systems using Dynamic programming	2
3.8	Scheduling of systems using linear programming.	1
4	UNIT COMMITMENT AND ECONOMIC DISPATCH	
4.1	Statement of Unit commitment (UC) problem; constraints in UC	1
4.2	Spinning reserve, thermal unit constraints, hydro constraints, fuel constraints	1
4.3	UC solution methods: Priority-list methods, forward dynamic programming approach	2
4.4	UC solution methods: numerical problems	1
4.5	Incremental cost curve, co-ordination equations without loss and with loss - direct method	1
4.6	λ – iteration method	1
4.7	Gradient method – Newton's method	1
4.8	Economic dispatch controller added to LFC control.	1
5	POWER SYSTEM SECURITY	
5.1	Need for power system Security	1
5.2	Contingency analysis - linear sensitivity factors	1
5.3	AC power flow methods	1
5.4	Contingency selection – concentric relaxation	1
5.5	Bounding-security constrained optimal power flow	1
5.6	Interior point algorithm	1
5.7	Bus incremental costs	1
5.8	Estimation of Average and Trend, Terms of Deterministic part of Load	1
5.9	Estimation of Stochastic part of Load	1
	Total	45

Course Designer:

Dr. Elango M K elango@ksrct.ac.in

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

61 PPS 103	SYSTEM THEORY
-------------------	----------------------

Category	L	T	P	Credit
PC	3	0	0	3

Objective

- To educate on modeling and representing systems in state variable form.
- To train on solving linear and non-linear state equations.
- To illustrate the properties of control system.
- To classify non-linearities and examine stability of systems in the sense of Lyapunov's theory.
- To educate on modal concepts, design of state, output feedback controllers and estimators.

Prerequisite

Control System

Course Outcomes

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

CO1	Understand the concept of State-State representation for Dynamic Systems	Understand
CO2	Explain the solution techniques of state equations	Remember
CO3	Realize the properties of control systems in state space form	Apply
CO4	Identify non-linearities and construct the phase trajectories	Analyse
CO5	Evaluate the stability of the system using Lyapunov.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	2	2
CO2	3	2	2	2	2	2
CO3	3	2	2	2	2	2
CO4	3	2	2	2	2	2
CO5	3	2	2	2	2	2

Assessment Pattern

Category	Continuous Assessment Tests		End Sem Examination
	1	2	
Remember	20	15	20
Understand	20	15	20
Apply	60	40	40
Analyse	0	30	20
Evaluate	0	0	0
Create	0	0	0

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

K.S.Rangasamy College of Technology – Autonomous R2018								
61 PPS 103 – System Theory								
M.E. Power Systems Engineering								
Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
I	3	0	3	3	3	40	60	100
STATE VARIABLE REPRESENTATION Introduction-Concept of State-Space equations for Dynamic Systems -Time invariance and linearity- Non uniqueness of state model- Physical Systems and State Assignment - free and forced responses- State Diagrams.								[9]
SOLUTION OF STATE EQUATIONS Existence and uniqueness of solutions to Continuous-time state equations - Solution of Nonlinear and Linear Time Varying State equations - State transition matrix and its properties – Evaluation of matrix exponential- System modes- Role of Eigen values and Eigen vectors.								[9]
PROPERTIES OF THE CONTROL SYSTEM Controllability and Observability- Stabilizability and Detectability-Test for Continuous time Systems- Time varying and Time invariant case-Output Controllability-Reducibility-System Realizations - Pole Placement by State Feedback for both SISO and MIMO Systems - Full Order and Reduced Order Observers.								[9]
NON-LINEAR SYSTEMS Equilibrium Points-Types of nonlinearity – Phase plane analysis – Singular points – Limit cycles – Construction of phase trajectories – Describing function method – Derivation of describing functions.								[9]
LYAPUNOVSTABILITY Equilibrium Stability of Nonlinear Continuous Time Autonomous Systems - Direct Method of Lyapunov and the Linear Continuous-Time Autonomous Systems- Lyapunov Functions for Nonlinear Continuous Time Autonomous Systems-Krasovskii and VariableGradient Method.								[9]
Total Hours								45
Text book(s):								
1	M. Gopal, “Modern Control System Theory”, New Age International, 2005.							
2	Z. Bubnicki, "Modern Control Theory", Springer, 2005							
Reference(s):								
1	K. Ogatta, “Modern Control Engineering”, PHI, 2002							
2	D. Roy Choudhury, “Modern Control Systems”, New Age International, 2005							
3	John J. D’Azzo, C. H. Houpis and S. N. Sheldon, “Linear Control System Analysis and Design with MATLAB”, Taylor Francis, 2003							
4	John S. Bay, “Fundamentals of Linear State Space Systems”, McGraw Hill, 2015							

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

Course Contents and Lecture Schedule

S.No.	Topic	No. of Hours
1	STATE VARIABLE REPRESENTATION	
1.1	Introduction-Concept of State-Space equations for Dynamic Systems	2
1.2	Time invariance and linearity	1
1.3	Non uniqueness of state model	1
1.4	Physical Systems and State Assignment	2
1.5	free and forced responses	1
1.6	State Diagrams	2
2	SOLUTION OF STATE EQUATIONS	
2.1	Existence and uniqueness of solutions to Continuous-time state equations	2
2.2	Solution of Nonlinear and Linear Time Varying State equations	1
2.3	State transition matrix and its properties	2
2.4	Evaluation of matrix exponential	1
2.5	System modes	2
2.6	Role of Eigen values and Eigen vectors.	1
3	PROPERTIES OF THE CONTROL SYSTEM	
3.1	Controllability and Observability	2
3.2	Stabilizability and Detectability	2
3.3	Test for Continuous time Systems	1
3.4	Time varying and Time invariant case	1
3.5	Output Controllability	1
3.6	Reducibility	1
3.7	System Realizations	1
4	NON-LINEAR SYSTEMS	
4.1	Equilibrium Points	1
4.2	Stability in the sense of Lyapunov	1
4.3	BIBO Stability-Stability of LTI Systems	1
4.4	Types of nonlinearity	1
4.5	Phase plane analysis	1
4.6	Singular points, Limit cycles	1
4.7	Construction of phase trajectories	1
4.8	Describing function method – Derivation of describing functions.	2
5	LYAPUNOV STABILITY	
5.1	Equilibrium Stability of Nonlinear Continuous Time Autonomous Systems	2
5.2	Direct Method of Lyapunov and the Linear Continuous-Time Autonomous Systems	3
5.3	Lyapunov Functions for Nonlinear Continuous Time Autonomous Systems	2
5.4	Krasovskii and Variable-Gradient Method	2

Course Designer

N.Kayalvizhi – kayalvizhi@ksrct.ac.in

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

60 PPS 104	Analysis of Power Converters	Category	L	T	P	Credit
		PC	3	0	0	3

Objective

- To comprehend the operation of single phase converters with various types of loads
- To gain knowledge on three phase converters with various types of loads
- To understand the working of single phase inverters and its control
- To enhance the knowledge on working of three phase inverters
- To provide the basic understanding on various multilevel topologies

Prerequisite

Basic knowledge on semiconductors and analog electronics, Power Electronics

Course Outcome

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

CO1	Explain the operation of single phase AC-DC converter for different types of loads	Understand
CO2	Analyze the performance parameters of three phase converters for various loads	Analyze
CO3	Illustrate the various PWM techniques involved in control of inverters	Apply
CO4	Discuss the various mode of operation in three phase inverters	Understand
CO5	Delineate the PWM techniques for Multilevel inverters	Understand

Mapping Programme Course Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	3	2
CO2	3	3	3	2	3	3
CO3	3	3	3	2	3	3
CO4	3	3	3	2	3	3
CO5	3	3	3	2	3	3

Assessment pattern

Bloom's Category	Continuous Assessment Tests (Marks)		End Sem Examination (Marks)
	1	2	
Remember	10	20	30
Understand	20	20	30
Apply	20	20	30
Analyse	10	0	10
Evaluate	0	0	0
Create	0	0	0

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

K.S.Rangasamy College of Technology – Autonomous R 2022								
60 PPS 104 - Analysis of Power Converters								
M.E. Power Systems Engineering								
Semester	Hours/Week			Total Hrs	Credit	Maximum Marks		
	L	T	P			C	CA	ES
I	3	0	0	45	3	40	60	100
SINGLE PHASE AC-DC CONVERTER Static Characteristics of power diode, SCR and GTO, half controlled and fully controlled converters with R-L, R-L-E loads and freewheeling diodes - continuous and discontinuous modes of operation- inverter operation and its limit -Sequence control of converters - performance parameters - effect of source impedance and overlap - reactive power and power balance in converter circuit.								[9]
THREE PHASE AC-DC CONVERTER Half controlled and fully controlled converters with R, R-L, R-L-E loads and freewheeling diodes - inverter operation and its limit – performance parameters - effect of source impedance and overlap -12 pulse converter - Applications - Excitation system, DC drive system.								[9]
SINGLE PHASE INVERTERS Introduction to self-commutated switches : MOSFET and IGBT - Principle of operation of half and full bridge inverters - Performance parameters - Voltage control of single phase inverters using various PWM techniques - various harmonic elimination techniques - Design of UPS - VSR operation								[9]
THREE PHASE INVERTERS 180 degree and 120 degree conduction mode inverters with star and delta connected loads - voltage control of three phase inverters: single, multi pulse, sinusoidal, space vector modulation techniques - VSR operation - Application - Induction heating, AC drive system - Current source inverters.								[9]
MODERN INVERTERS Multilevel concept - diode clamped - flying capacitor - cascaded type multilevel inverters - Comparison of multilevel inverters - application of multilevel inverters - PWM techniques for MLI - Single phase &Three phase Impedance source inverters - Filters								[9]
Total Hours								45
Text book(s):								
1.	Rashid M.H., “Power Electronics Circuits, Devices and Applications ”, Pearson, fourth Edition, 10 th Impression 2021.							
2.	Bin Wu, Mehdi Narimani, "High-Power Converters and AC Drives", Wiley, 2nd Edition,2017.							
Reference(s):								
1.	Ned Mohan, T.M.Undeland and W.P.Robbins, “Power Electronics: converters,Application and design”, 3 rd edition Wiley, 2007.							
2.	P.S.Bimbra, “Power Electronics”, Khanna Publishers, Eleventh Edition, 2003.							
3.	Jai P. Agrawal, “Power Electronics System Theory and Design”, Pearson Education, FirstEdition, 2015.							
4.	Bimal.K.Bose “Modern Power Electronics and AC Drives”, Pearson Education, SecondEdition, 2003.							

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

Course Contents and Lecture Schedule

S.No.	Topic	No. Hrs
1.SINGLE PHASE AC-DC CONVERTER		
1.1.	Static Characteristics of power diode	1
1.2.	Static Characteristics of SCR and GTO	1
1.3.	Half controlled converters with R-L, R-L-E loads and freewheeling diodes	1
1.4.	Fully controlled converters with R-L, R-L-E loads and freewheeling diodes	1
1.5.	Continuous and discontinuous modes of operation-inverter operation and its limit	1
1.6.	Sequence control of converters	1
1.7.	Performance parameters	1
1.8.	effect of source impedance and overlap	1
1.9.	Reactive power and power balance in converter circuit	1
2 .THREE PHASE AC-DC CONVERTER		
2.1.	Half controlled converters with R, R-L, R-L-E loads and freewheeling diodes	1
2.2.	Fully controlled converters with R, R-L, R-L-E loads and freewheeling diodes	2
2.3.	Inverter operation and its limit	1
2.4.	Performance parameters	1
2.5.	Effect of source impedance and overlap	1
2.6.	12 pulse converter	1
2.7.	Applications - Excitation system	1
2.8.	Applications - DC drive system	1
3.SINGLE PHASE INVERTERS		
3.1.	Introduction to self-commutated switches : MOSFET and IGBT	2
3.2.	Principle of operation of half bridge inverters	1
3.3.	Principle of operation of full bridge inverters	1
3.4.	Performance parameters	1
3.5.	Voltage control of single phase inverters using various PWM techniques	1
3.6.	Various harmonic elimination techniques	1
3.7.	Design of UPS	1
3.8.	VSR operation	1
4.THREE PHASE INVERTERS		
4.1.	180 degree and 120 degree conduction mode inverters with star and delta connected loads	2
4.2.	Voltage control of three phase inverters: single, multi pulse, sinusoidal,	1
4.3.	Space vector modulation techniques	1
4.4.	VSR operation - Application - Induction heating	2
4.5.	Application - AC drive system	1
4.6.	Current source inverters.	2
5.MODERN INVERTERS		
5.1.	Multilevel concept - diode clamped	1
5.2.	Flying capacitor	1
5.3.	Cascaded type multilevel inverters	1
5.4.	Comparison of multilevel inverters	1
5.5.	Application of multilevel inverters	1
5.6.	PWM techniques for MLI	1
5.7.	Single phase Impedance source inverters	1
5.8.	Three phase Impedance source inverters - Filters	2

Course DesignerDr.R.Balamurugan – balamurugan@ksrct.ac.in

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

60 PED 001	Research Methodology and IPR	Category	L	T	P	Credit
		PC	3	0	0	3

Objective(s)

- To understand the principles of research process.
- To develop knowledge in analytical skills for collection of research data.
- To understand the procedure in the preparation of reports.
- To accomplish basic idea about the process involved in intellectual property rights.
- To enlighten the process of patent filing.

Pre-requisite

Nil

Course Outcomes

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

CO1	To understand the research process and design.	Remember, Understand, Apply
CO2	To gain the knowledge about sources and collection of research data	Remember, Understand, Analyze
CO3	To understand the procedure of data analysis, preparation of reports and checking plagiarism	Remember, Understand, Analyze
CO4	To gain the knowledge on Trade mark and functions of UNESCO in IPR	Remember, Understand, Apply
CO5	To enlighten the benefits, E-filing and Examinations related to patents	Remember, Understand, Apply

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	2	2
CO2	3	3	2	2	2	2
CO3	3	3	2	2	2	2
CO4	3	3	2	2	2	2
CO5	3	3	2	2	2	2

Note: 3 – Strong Contribution; 2 – Average Contribution; 1 – Some Contribution

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		End Semester Examination (Marks)
	1	2	
Remember	10	10	30
Understand	20	20	30
Apply	30	30	30
Analyse	0	0	10
Evaluate	0	0	0
Create	0	0	0

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

K.S.Rangasamy College of Technology – Autonomous R2022								
60 PED 001 - Research Methodology and IPR								
Common to all Branches								
Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
I	3	0	0	30	3	40	60	100
Research Design Overview of research process and design- Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys, Selection of the Right Medium and Journal for publication, Translation of Research								[9]
Data Collection and Sources Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.								[9]
Data Analysis and Reporting Overview of Multivariate Analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation. Checks for Plagiarism, Falsification, Fabrication, and Misrepresentation								[9]
Intellectual Property Rights Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.								[9]
Patents Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.								[9]
Total Hours								45
Text Book(s):								
1.	David I. Bainbridge, “Intellectual Property”, Longman, 9th Edition, 2012.							
2	Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).							
Reference(s):								
1.	Chawla H S., “Introduction to Intellectual Property Rights”, CBS PUB & DIST PVT Limited, INDIA, 2019.							
2.	Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007							
3.	David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007							
4.	Arun K. Narasani, Kankanala K.C., Radhakrishnan V., “Indian Patent Law and Practice”, Oxford University Press, 2010.							
5.	Richard Stim, “Patent, Copyright & Trademark - An Intellectual Property Desk Reference”, NOLO Publishers, 2020.							
6.	The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.							

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

Course Content and Lecture Schedule

S.No.	Topics	No.of hours
1.0	Research Design	
1.1	Overview of research process and design	1
1.2	Use of Secondary and exploratory data to answer the research question	2
1.3	Qualitative research	1
1.4	Observation studies	1
1.5	Experiments and Surveys	1
1.6	Selection of the Right Medium and Journal for publication	2
1.7	Translation of Research	1
2.0	Data Collection and Sources	
2.1	Measurements, Measurement Scales	2
2.2	Questionnaires and Instruments	2
2.3	Sampling and methods	2
2.4	Data - Preparing, Exploring, examining and displaying	3
3.0	Data Analysis and Reporting	
3.1	Overview of Multivariate analysis	1
3.2	Hypotheses testing and Measures of Association	2
3.3	Presenting Insights	1
3.4	Findings using written reports and oral presentation	2
3.5	Checks for Plagiarism	1
3.6	Falsification	1
3.7	Fabrication, and Misrepresentation	1
4.0	Intellectual Property Rights	
4.1	Intellectual Property – The concept of IPR	1
4.2	Evolution and development of concept of IPR, IPR development process	2
4.3	Trade secrets, utility Models, IPR & Bio diversity	2
4.4	Role of WIPO and WTO in IPR establishments	1
4.5	Right of Property, Common rules of IPR practices	1
4.6	Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance	2
5.0	Patents	
5.1	Patents – objectives and benefits of patent, Concept, features of patent	2
5.2	Inventive step, Specification, Types of patent application	2
5.3	Process E-filing, Examination of patent	1
5.4	Grant of patent, Revocation	1
5.5	Equitable Assignments, Licences, Licensing of related patents	2
5.6	Patent agents, Registration of patent agents	1

Course Designer

Dr.A.Murugesan – murugesana@ksrct.ac.in

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

K.S.Rangasamy College of Technology – Autonomous R 2022								
60 PPS 1P1 – POWER SYSTEM LABORATORY- I								
M.E. Power Systems Engineering								
Semester	Hours / Week			Total Hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
I	0	0	4	60	2	60	40	100
Objectives								
- To present a problem-oriented knowledge of power flow analysis methods - To address the concepts stability analysis - To understand the concept of economic dispatch problems solution by using software. - To understand the concept of load flow analysis by using software. - To identify and formulate solutions to problems relevant to power system using software tools.								

Prerequisite

Nil

Course Outcomes

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

CO1	To analysis the different methods of load flow problems by simulation.	Analysis
CO2	To analysis Transient stability analysis of power system by using simulink model.	Analysis
CO3	To simulate the power system operation and control.	Create
CO4	To analysis Harmonic Analysis of power system by using simulink model.	Analysis
CO5	To analysis the Demand Side Management in Smart Power Grid environment	Analysis

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	3	3
CO2	3	3	3	2	3	3
CO3	3	3	3	2	3	3
CO4	3	3	3	2	3	3
CO5	3	3	3	2	3	3

List of Experiments

- Power flow analysis by Newton-Raphson/ Fast decoupled method
- Transient stability analysis of single machine-infinite bus system using classical machine model
- Economic load dispatch using lambda-iteration method
- Unit commitment: Priority-list scheme and dynamic programming
- Contingency analysis: Generator shift factors and line outage distribution factors
- Load flow analysis of two-bus system with STATCOM
- Available Transfer Capability (ATC) calculation using an existing load flow program in deregulated environment.
- Harmonic Analysis of Power system with nonlinear load
- Study of protective relaying schemes of Power Apparatus.
- Demand Side Management in Smart Power Grid environment
- Determination of Sequence Impedances of Power Network

Course Designer

Dr.T.Venkatesan venkatesan@ksrct.ac.in

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

K.S.Rangasamy College of Technology – Autonomous R 2022								
60 PPS 1P2 – Power Converters Laboratory								
PPS: M.E. Power Systems Engineering								
Semester	Hours / Week			Total	Credit	Maximum Marks		
	L	T	P	Hrs	C	CA	ES	Total
I	0	0	4	60	2	60	40	100
Objectives								
- To provide the basic understanding on the switching of power semiconductor switches - To understand about the working of converters with different types of loads - To acquire knowledge on the design of PWM inverters - To facilitate the students to understand about the z source networks - To familiarize the fundamentals of multilevel topologies								

Prerequisite

Nil

Course Outcomes

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

CO1	Illustrate the switching of power electronic switches	Analysis
CO2	Simulate and analyze the performance of the converters for different loads	Analysis
CO3	Analyze the control of three phase inverters.	Analyse
CO4	Develop a inverter with different PWM techniques	Analysis
CO5	Design and simulate various topologies of multilevel inverters	Analysis

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	3	2
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3

List of Experiments

- Study of switching characteristics of Power MOSFET & IGBT.
- Simulation of Three-phase semi-converter with R, RL & RLE load.
- Simulation of Three-phase fully controlled converter with R, RL & RLE load.
- Simulation of single phase full bridge inverters.
- Simulation of Three-phase Voltage Source Inverter
- Simulation of PWM inverter for various modulation indices.
- Simulation of a UPS system.
- Simulation of a single-phase Z-source inverter with R load.
- Simulation of a five-level cascaded multilevel inverter with R load.
- Simulation of a capacitor clamped multilevel inverter with R load

Course Designer

Dr.R.Balamurugan – balamurugan@ksrct.ac.in

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

SEMESTER II

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1.	60 PPS 201	Advanced Power System Protection	PC	3	3	0	0	3
2.	60 PPS 202	Power System Dynamics	PC	5	3	2	0	4
3.	60 PPS 203	Power System Transients	PC	3	3	0	0	3
4.	60 PPS 204	Restructured Power System	PC	3	3	0	0	3
5.	60 PPS E1*	Professional Elective I	PE	3	3	0	0	3
6.	60 PPS E2*	Professional Elective II	PE	3	3	0	0	3
7.	60 PAC 002	Disaster Management	AC	2	2	0	0	0
PRACTICALS								
8.	60 PPS 2P1	Power System Laboratory – II	PC	4	0	0	4	2
9.	60 PPS 2P2	Technical Seminar / Mini Project	CGS	4	0	0	4	0
TOTAL				30	20	2	8	21

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

K.S.RANGASAMY COLLEGE OF TECHNOLOGY, TIRUCHENGODE - 637215

(An Autonomous Institution affiliated to Anna University)

M.E./M.Tech. Degree Programme

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2022-2023 onwards)

SECOND SEMESTER

S.No.	Course Code	Name of the Course	Duration of Internal Exam	Weightage of Marks			Minimum Marks for Pass in End Semester Exam	
				Continuous Assessment*	End Semester Exam**	Max. Marks	End Semester Exam	Total
THEORY								
1	60 PPS 201	Advanced Power System Protection	2	40	60	100	45	100
2	60 PPS 202	Power System Dynamics	2	40	60	100	45	100
3	60 PPS 203	Power System Transients	2	40	60	100	45	100
4	60 PPS 204	Restructured Power System	2	40	60	100	45	100
5	60 PPS E1*	Professional Elective I	2	40	60	100	45	100
6	60 PPS E2*	Professional Elective II	2	40	60	100	45	100
7	60 PAC 001	English for Research Paper Writing	2	100	-	100	-	100
PRACTICAL								
7	60 PPS 2P1	Power System Laboratory – II	3	60	40	100	45	100
8	60 PPS 2P2	Technical Seminar / Mini Project	3	100	-	100	-	100

*CA evaluation pattern will differ from course to course and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern.

** End Semester Examination will be conducted for maximum marks of 100 and subsequently be reduced to 60 marks for the award of terminal examination marks

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

60 PPS 201	Advanced Power System Protection	Category	L	T	P	Credit
		PC	3	0	0	3

Objective

- To demonstrate the basic concepts and recent trends in power system protection
- To design and work with the concepts of digital and numerical relaying of various power apparatuses
- To train up with the relay coordination for the transmission line protection schemes
- To expose PC applications for designing protective relaying schemes
- To compare different protection schemes of a power apparatus through performance analysis

Prerequisite

Power System Protection and Switchgear

Course Outcomes

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

CO1	Familiarize the underlying principle of digital techniques for power system protection	Apply
CO2	Design the relaying scheme for protection of power apparatus using digital techniques	Analyze
CO3	Analyse and interpret relay coordination	Analyze
CO4	Develop PC based algorithm for short circuit studies	Understand
CO5	Compare the performance of modern protection schemes with the conventional schemes	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	2	2
CO2	3	3	3	3	3	2
CO3	3	3	3	3	2	3
CO4	3	3	3	2	3	2
CO5	3	3	3	3	3	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests(Marks)		End Sem Examination (Marks)
	1	2	
Remember	10	10	20
Understand	20	20	30
Apply	10	10	20
Analyse	20	20	30
Evaluate	0	0	0
Create	0	0	0

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

K.S.Rangasamy College of Technology – Autonomous R 2022								
60 PPS 201 – Advanced Power System Protection								
M.E. Power Systems Engineering								
Semester	Hours/Week			Total Hrs	Credit	Maximum Marks		
	L	T	P			C	CA	ES
II	3	0	0	45	3	40	60	100
NUMERICAL PROTECTION Introduction - Block diagram of numerical relay - Sampling theorem - Correlation with a reference wave - Least Error Squared (LES) technique - Digital filtering and numerical over- Current protection								[9]
DIGITAL PROTECTION OF TRANSMISSION LINE Introduction - Protection scheme of transmission line — Distance relays - Traveling wave relays - Digital protection scheme based upon fundamental signal - Hardware design - Software design - Digital protection of EHV/UHV transmission line based upon traveling wave phenomenon - New relaying scheme using amplitude comparison.								[9]
DIGITAL PROTECTION OF SYNCHRONOUS GENERATOR AND TRANSFORMER Introduction- Faults in Synchronous Generator- Protection Schemes for Synchronous Generator- Digital Protection of Synchronous Generator- Faults in a Transformer- Schemes used for transformer protection- Digital Protection of Transformer.								[9]
DISTANCE AND OVERCURRENT RELAY SETTING AND CO-ORDINATION Directional instantaneous IDMT over current relay - Directional multi-Zone distance relay – Distance relay Man-machine interface subsystem - Integrated operation of natural power system- Application of computer graphics.								[9]
PC APPLICATIONS FOR DESIGNING PROTECTIVE RELAYING SCHEME Types of faults — Assumptions - Development of algorithm for SC studies - PC based integrated software for SC studies – Transformation to component quantities- SC studies of multiphase systems – Ultrahigh speed protective relays for high voltage long transmission line.								[9]
Total Hours								45
Text book(s):								
1.	L.P.Singh, "Digital Protection – Protective Relaying from Electro mechanical to Microprocessor" , New Age International Ltd., New Delhi, Second Edition, 2006							
2.	S.R.Bhide, “Digital Power System Protection”, Prentice Hall of India Pvt. Ltd., New Delhi, 2014							
Reference(s):								
1.	Paithankar and Bhide, “Fundamentals of Power System Protection”, Prentice Hall of India Pvt. Ltd., New Delhi, second edition, 2010.							
2.	Paithankar, “Transmission Network Protection”, Marcel & Dekker, New York, 1998.							
3.	Stanley Horowitz, “Protective Relaying for Power System II”, John Wiley & Sons, 2008.							
4.	T.S.M.Rao, “Digital/ Numerical relays”, Tata McGraw Hill, New Delhi, 2005.							

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

Rev.No.02 / w.e.f. 12/06/2023
Passed in BoS Meeting held on 13/05/2023
Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

Course Contents and Lecture Schedule

S.No	Topic	# Hrs
1	Introduction	
1.1	NUMERICAL PROTECTION	1
1.2	Block diagram of numerical relay & Sampling theorem	2
1.4	Correlation with a reference wave	2
1.5	Least Error Squared (LES) technique	1
1.6	Digital filtering and numerical over	1
1.7	Current protection	1
2	DIGITAL PROTECTION OF TRANSMISSION LINE	
2.1	Introduction	1
2.2	Protection scheme of transmission line	1
2.3	Distance relays	1
2.4	Traveling wave relays	1
2.5	Digital protection scheme based upon fundamental signal	1
2.6	Hardware design Software design	1
2.7	Digital protection of EHV/UHV transmission line based upon traveling wave phenomenon	1
2.8	Effect of source regulation	1
2.9	New relaying scheme using amplitude comparison.	1
3	Digital protection of synchronous generator & transformer	
3.1	Introduction	1
3.2	Faults in synchronous generator	2
3.3	Protection schemes for Synchronous Generator	1
3.4	Digital protection of Synchronous Generator	1
3.5	Faults in a Transformer	2
3.6	Schemes used for Transformer Protection	1
3.7	Digital Protection of Transformer.	1
4	Distance and overcurrent relay setting and co-ordination	
4.1	Directional instantaneous	1
4.2	IDMT over current relay	1
4.3	Directional multi-Zone distance relay	1
4.4	Distance relay setting	1
4.5	Co-ordination of distance relays	1
4.6	Co-ordination of over current relays	1
4.7	Computer graphics display	1
4.8	Man-machine interface subsystem	1
4.9	Integrated operation of national power system Application of computer graphics	1
5	PC APPLICATIONS FOR DESIGNING PROTECTIVE RELAYING SCHEME	
5.1	Types of faults — Assumptions	1
5.2	Development of algorithm for SC studies	2
5.3	PC based integrated software for SC studies	1
5.4	Transformation to component quantities	2
5.5	SC studies of multiphase systems	1
5.6	Ultra high speed protective relays for high voltage long transmission line.	2
	Total	45

Course Designers

- Ms.S.Jaividhya - jaividhya@ksrct.ac.in

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


 BoS Chairman Signature

60 PPS 202	POWER SYSTEM DYNAMICS	Category	L	T	P	Credit
		PC	3	2	0	4

Objective

- To recognize dynamic performance of power systems.
- To make and gain the knowledge on modeling of synchronous machine and its excitation, speed governing system.
- To attain the knowledge of design of controllers for small signal stability analysis.
- To familiarize about the stability analysis of dynamic power system.
- To gain the knowledge on enhancement of small signal stability.

Prerequisite

POWER SYSTEM OPERATION AND CONTROL(UG)

Course Outcomes

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

CO1	Impart the knowledge on dynamic modeling of a synchronous machine.	Analyze
CO2	Describe the modeling of excitation and speed governing system.	Apply
CO3	Attain the knowledge about stability of dynamic systems.	Understand
CO4	Understand the significance about small signal stability analysis with controllers.	Analyze
CO5	Implement the enhancement methods for small signal stability problems.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	3	-	2	1
CO2	1	2	-	2	-	-
CO3	2	3	3	-	3	-
CO4	3	1	-	3	1	-
CO5	3	2	-	3	-	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		End Sem Examination (Marks)
	1	2	
Remember	10	20	30
Understand	20	20	30
Apply	20	10	30
Analyze	10	10	10
Evaluate	0	0	0
Create	0	0	0

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

K.S.Rangasamy College of Technology - Autonomous R2022**60 PPS 202 – POWER SYSTEM DYNAMICS****M.E - POWER SYSTEM ENGINEERING**

Semester	Hours / Week			Total hrs	Credit	Maximum Marks		
	L	T	P			CA	ES	Tot
II	3	2	0	60	4	40	60	100

Modelling of Synchronous Machine

Schematic Diagram, Physical Description: armature and field structure, machines with multiple pole pairs, mmf waveforms, direct and quadrature axes, Mathematical Description of a Synchronous Machine: Basic equations of a synchronous machine: stator circuit equations, stator self, stator mutual and stator to rotor mutual inductances, dq0 Transformation: flux linkage and voltage equations for stator and rotor in dq0 coordinates, electrical power and torque, physical interpretation of dq0 transformation, Per Unit Representations: power invariant form of Park's transformation; Equivalent Circuits for direct and quadrature axes, Steady-state Analysis: Voltage, current and flux-linkage relationships, Phasor representation, Rotor angle, Steady-state equivalent circuit, Computation of steady-state values, Equations of Motion: Swing Equation, calculation of inertia constant, Representation in system studies, Synchronous Machine Representation in Stability Studies: Simplifications for large-scale studies: Neglect of stator transients, Simplified model with amortisseurs neglected: two-axis model with amortisseur windings neglected, classical model

[9]**Modelling of Excitation and Speed Governing System**

Excitation System Requirements; Elements of an Excitation System; Types of Excitation System; Control and protective functions; IEEE (1992) block diagram for simulation of excitation systems. Turbine and Governing System Modeling: Functional Block Diagram of Power Generation and Control, Schematic of a hydroelectric plant, classical transfer function of a hydraulic turbine (no derivation), special characteristic of hydraulic turbine, electrical analogue of hydraulic turbine, Governor for Hydraulic Turbine: Requirement for a transient droop, Block diagram of governor with transient droop compensation, Steam turbine modeling: Single reheat tandem compounded type only and IEEE block diagram for dynamic simulation; generic speed-governing system model for normal speed/load control function

[9]**Small Signal Stability Analysis Without Controllers**

Classification of Stability, Basic Concepts and Definitions: Rotor angle stability, The Stability Phenomena. Fundamental Concepts of Stability of Dynamic Systems: State-space representation, stability of dynamic system, Linearization, Eigen properties of the state matrix: Eigen values and eigen vectors, modal matrices, Eigen value and stability, mode shape and participation factor. Single-Machine Infinite Bus (SMIB) Configuration: Classical Machine Model stability analysis with numerical example, Effects of Field Circuit Dynamics: synchronous machine, network and linearised system equations, block diagram representation with K- constants; expression for K- constant (no derivation), effect of field flux variation on system stability: analysis with numerical example.

[9]**Small Signal Stability Analysis With Controllers**

Effects Of Excitation System: Equations with definitions of appropriate K-constants and simple thyristor excitation system and AVR, block diagram with the excitation system, analysis of effect of AVR on synchronizing and damping components using a numerical example, Power System Stabilizer: Block diagram with AVR and PSS, Illustration of principle of PSS application with numerical example, Block diagram of PSS with description, system state matrix including PSS, analysis of stability with numerical example. Multi-Machine Configuration: Equations in a common reference frame, equations in individual machine rotor coordinates, illustration of formation of system state matrix for a two-machine system with classical models for synchronous machines, illustration of stability analysis using a numerical example. Principle behind small-signal stability improvement methods: delta-omega and delta P-omega stabilizers.

[9]**Enhancement of Small Signal Stability**

Power System Stabilizer – Stabilizer based on shaft speed signal (delta omega) – Delta –P- Omega Stabilizer-Frequency-based stabilizers – Digital Stabilizer – Excitation control design – Exciter gain – Phase lead compensation – Stabilizing signal without stabilizer gain – Stabilizer limits.

[9]**Total Hours: 45+15=60****Text book(s):**

Rev.No. 02 / w.e.f. 12.06.2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023

BoS Chairman Signature

1.	Power System Dynamics Stability and Control By K R Padiyar, B S Publications -2008.
2.	P.M. Anderson and A. A. Fouad, "Power system control and stability", IEEE Press
Reference(s):	
1.	Power System Stability & Control, By- P.Kundur, Tata Mcgraw hill-2008.
2.	Power Systems Analysis By Vijay Vittal, Bergen, Pearson Education-2009.
3.	R.Ramunujam," Power System Dynamics Analysis and Simulation, PHI Learning Private Limited, New Delhi, 2009
4.	Electric machinery and Drive Systems By P C Crause, Wiley IEEE Press -2013.

Course Contents and Lecture Schedule

S.No	Topic	#Hrs	MoD
1. Modelling of Synchronous Machine			
1.1	Schematic Diagram, Physical Description: armature and field structure, machines with multiple pole pairs, mmf waveforms, direct and quadrature axes.	02	LWD
1.2	Mathematical Description of a Synchronous Machine: Basic equations of a synchronous machine: stator circuit equations, stator self, stator mutual and stator to rotor mutual inductances, dq0 Transformation: flux linkage and voltage equations for stator and rotor in dq0 coordinates.	02	LWD
1.3	Electrical power and torque, physical interpretation of dq0 transformation, Per Unit Representations: power invariant form of Park's transformation; Equivalent Circuits for direct and quadrature axes.	01	LWD
1.4	Steady-state Analysis: Voltage, current and flux-linkage relationships, Phasor representation, Rotor angle, Steady-state equivalent circuit, Computation of steady-state values.	02	LWD
	TUTORIAL-1: Mathematical description of synchronous machine and steady state analysis.	02	
1.6	Equations of Motion: Swing Equation, calculation of inertia constant, Representation in system studies.	01	LWD
1.7	Synchronous Machine Representation in Stability Studies	01	LWD
1.8	Simplifications for large-scale studies: Neglect of stator transients		LWD
1.9	Simplified model with amortisseurs neglected: two-axis model with amortisseur windings neglected, classical model.		LWD
	TUTORIAL-2: Equations of motion-Swing equation.	02	
2. Modelling of Excitation and Speed Governing System			
2.1	Excitation System Requirements; Elements of an Excitation System; Types of Excitation System; Control and protective functions.	02	LWD
2.2	IEEE (1992) block diagram for simulation of excitation systems.	01	LWD
2.3	Turbine and Governing System Modeling: Functional Block Diagram of Power Generation and Control, Schematic of a hydroelectric plant.	02	LWD
2.4	classical transfer function of a hydraulic turbine (no derivation), special characteristic of hydraulic turbine, electrical analogue of hydraulic turbine.	01	LWD
2.5	Governor for Hydraulic Turbine: Requirement for a transient droop, Block diagram of governor with transient droop compensation,	01	LWD
2.6	Steam turbine modeling: Single reheat and compound type only and IEEE block diagram for dynamic simulation.	01	LWD
2.7	Generic speed-governing system model for normal speed/load control function.	01	LWD
	TUTORIAL-3: Hydraulic and steam turbine modelling	02	
3. Small Signal Stability Analysis Without Controllers			
3.1	Classification of Stability, Basic Concepts and Definitions: Rotor angle stability, The	01	LWD

Rev.No. 02 / w.e.f. 12.06.2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

	Stability Phenomena.		
3.2	Fundamental Concepts of Stability of Dynamic Systems: State-space representation, stability of dynamic system, Linearization.	02	LWD
3.3	Eigen properties of the state matrix: Eigen values and eigenvectors, modal matrices, Eigen value and stability, mode shape and participation factor.	01	LWD
	TUTORIAL-4: Eigen values and eigenvectors, modal matrices	02	
3.4	Single-Machine Infinite Bus (SMIB) Configuration: Classical Machine Model stability analysis with numerical example.	02	LWD
3.5	Effects of Field Circuit Dynamics: synchronous machine, network and linearised system equations, block diagram representation with K- constants.	01	LWD
3.6	Expression for K- constant.	01	LWD
3.7	Effect of field flux variation on system stability: analysis with numerical example.	01	LWD
	TUTORIAL-5: Classical Machine- Model stability analysis	02	
4. Small Signal Stability Analysis With Controllers			
4.1	Effects of Excitation System: Equations with definitions of appropriate K-constants and simple thyristor excitation system and AVR. Block diagram with the excitation system.	02	LWD
4.2	Analysis of effect of AVR on synchronizing and damping components using a numerical example.	01	LWD
	TUTORIAL-6: Analysis of effect of AVR on synchronizing and damping components.	02	
4.3	Power System Stabilizer: Block diagram with AVR and PSS, Illustration of principle of PSS application with numerical example.	01	LWD
4.4	Block diagram of PSS with description, system state matrix including PSS, analysis of stability with numerical example.	01	LWD
4.5	Multi-Machine Configuration: Equations in a common reference frame, equations in individual machine rotor coordinates.	01	LWD
4.6	Illustration of formation of system state matrix for a two-machine system with classical models for synchronous machines, illustration of stability analysis using a numerical example.	01	LWD
4.7	Principle behind small- signal stability improvement methods.	01	LWD
4.8	Delta-omega and delta P-omega stabilizers.	01	LWD
	TUTORIAL-7: Principle of PSS application, Analysis of stability in a single and multiple machines.	02	
5. Enhancement of Small Signal Stability			
5.1	Power System Stabilizer.	01	LWD
5.2	Stabilizer based on shaft speed signal (delta omega).	01	LWD
5.3	Delta -P- Omega Stabilizer, Frequency-based stabilizers, Digital Stabilizer.	02	LWD
5.4	Excitation control design, Exciter gain.	02	LWD
5.5	Phase lead compensation.	02	LWD
5.6	Stabilizing signal without stabilizer gain, Stabilizer limits.	01	LWD
	TUTORIAL-8: Excitation control design, Exciter gain.	02	

Course Designers

S.Srinivasan

-srinivasan@ksrct.ac.in

Rev.No. 02 / w.e.f. 12.06.2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

60 PPS 203	Power System Transients	Category	L	T	P	Credit
		PC	3	0	0	3

Objective

- Causes of transients and its effect and role in system planning.
- Generation of switching transients and their control using circuit – theoretical concept.
- Mechanism of lightning strokes and the production of lightning surges.
- Propagation, reflection and refraction of travelling waves.
- Voltage transients caused by faults, circuit breaker action, load rejection on integrated power system.

Prerequisite

Power System Analysis

Course Outcomes

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

CO1	Understand and analyze switching and lightning transients.	Apply
CO2	Acquire knowledge on generation of switching transients and their control.	Analyze
CO3	Analyze the mechanism of lightning strokes.	Analyze
CO4	Understand the importance of propagation, reflection and refraction of travelling waves.	Understand
CO5	Understand the concept of circuit breaker action, load rejection on integrated power system.	Understand

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	3	2
CO2	3	3	3	3	3	2
CO3	3	3	2	3	3	3
CO4	3	3	3	3	2	3
CO5	3	3	3	2	2	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests(Marks)		End Sem Examination(Marks)
	1	2	
Remember	10	10	20
Understand	20	20	30
Apply	10	10	20
Analyse	20	20	30
Evaluate	0	0	0
Create	0	0	0

K.S.Rangasamy College of Technology – Autonomous R2022								
60 PPS 203 - Power System Transients								
M.E. Power Systems Engineering								
Semester	Hours / Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	100
INTRODUCTION Review and importance of the study of transients - causes for transients. RL circuit transient with sine wave excitation - double frequency transients - basic transforms of the RLC circuit transients. Different types of power system transients - effect of transients on power systems – role of the study of transients in system planning.								[9]
SWITCHING TRANSIENTS Over voltages due to switching transients - resistance switching and the equivalent circuit for interrupting the resistor current - load switching and equivalent circuit - waveforms for transient voltage across the load and the switch - normal and abnormal switching transients. Current suppression - current chopping - effective equivalent circuit. Capacitance switching - effect of source regulation - capacitance switching with a restrike, with multiple restriks. Illustration for multiple restriking transients - ferro resonance.								[9]
LIGHTNING TRANSIENTS Review of the theories in the formation of clouds and charge formation - rate of charging of thunder clouds – mechanism of lightning discharges and characteristics of lightning strokes – model for lightning stroke - factors contributing to good line design - protection using ground wires - tower footing resistance - Interaction between lightning and power system								[9]
TRAVELING WAVES ON TRANSMISSION LINE COMPUTATION OF TRANSIENTS Computation of transients - transient response of systems with series and shunt lumped parameters and distributed lines. Traveling wave concept - step response - Bewely's lattice diagram - standing waves and natural frequencies - reflection and refraction of travelling waves.								[9]
TRANSIENTS IN INTEGRATED POWER SYSTEM The short line and kilometric fault - distribution of voltages in a power system - Line dropping and load rejection - voltage transients on closing and reclosing lines - over voltage induced by faults -switching surges on integrated system Qualitative application of EMTP for transient computation.								[9]
Total Hours								45
Text Book(s):								
1.	Allan Greenwood, 'Electrical Transients in Power Systems', Wiley Inter Science, New York, 2ndEdition, 1991.							
2.	Pritindra Chowdhari, "Electromagnetic transients in Power System", John Wiley and Sons Inc., Second Edition, 2009.							
3.	C.S. Indulkar, D.P.Kothari, K. Ramalingam, 'Power System Transients – A statistical approach', PHI Learning Private Limited. Second Edition. 2010.							
Reference(s):								
1.	Kothari DP and I.J Nagrath, "Basic Electrical Engineering", Fourth Edition, McGraw Hill Education, 2019.							
2.	Albert Malvino, David Bates, 'Electronic Principles, McGraw Hill Education; 7th edition, 2017.							
3.	Mahmood Nahvi and Joseph A. Edminister, "Electric Circuits", Schaum' Outline Series, McGraw Hill, 2002.							
4.	H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw-Hill, New Delhi, 2010.							

Rev.No. 02 / w.e.f. 12.06.2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

Course Contents and Lecture Schedule

S.No	Topic	#Hrs
1	INTRODUCTION AND SURVEY	
1.1	Review and importance of the study of transients	1
1.2	Causes for transients	1
1.3	RL circuit transient with sine wave excitation	2
1.4	Double frequency transients	2
1.5	Different types of power system transients	1
1.6	Effect of transients on power systems	1
1.7	Role of the study of transients in system planning.	1
2	SWITCHING TRANSIENTS	
2.1	Over voltages due to switching transients	1
2.2	Resistance switching and the equivalent circuit for interrupting the resistor current	1
2.3	Waveforms for transient voltage across the load and the switch	1
2.4	Normal and abnormal switching transients	1
2.5	Current suppression - current chopping	1
2.6	Effective equivalent circuit	1
2.7	Capacitance switching & Effect of source regulation	2
2.8	Capacitance switching with a restrike, with multiple restrikes	1
3	LIGHTNING TRANSIENTS	
3.1	Review of the theories in the formation of clouds and charge formation	1
3.2	Rate of charging of thunder clouds	2
3.3	Mechanism of lightning discharges and characteristics of lightning strokes	1
3.4	Model for lightning stroke	1
3.5	Factors contributing to good line design	1
3.6	Protection using ground wires & Tower footing resistance	2
3.7	Interaction between lightning and power system	1
4	TRAVELING WAVES ON TRANSMISSION LINE COMPUTATION OF TRANSIENTS	
4.1	Computation of transients	1
4.2	Transient response of systems with series and shunt lumped parameters and DL	1
4.3	Traveling wave concept	2
4.4	Step response	1
4.5	Bewely's lattice diagram	2
4.6	Standing waves and natural frequencies	1
4.7	Reflection and refraction of travelling waves.	1
5	TRANSIENTS IN INTEGRATED POWER SYSTEM	
5.1	The short line and kilometric fault	1
5.2	Distribution of voltages in a power system	2
5.3	Voltage transients on closing and reclosing lines & Over voltage induced by faults	2
5.4	Switching surges on integrated system	1
5.5	Qualitative application of EMTP for transient computation.	2
	Total	45

Course Designers

Ms.S.Jaividhya

- jaividhya@ksrct.ac.in

Rev.No. 02 / w.e.f. 12.06.2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


 BoS Chairman Signature

60 PPS 204	Restructured Power System
-------------------	----------------------------------

Category	L	T	P	Credit
PC	3	0	0	3

Objective

- Describe the behavior of deregulated markets in power system
- Describe the technical and non-technical issues in deregulated power industry
- Identify the methods of Local Marginal prices calculation in transmission and the function of financial transmission rights
- Analyze the energy and ancillary services management in deregulated power industry
- Discriminate the restructuring framework US and Indian power sectors

Prerequisite

Generation, Transmission and Distribution, Power System Analysis, Power System Operation and Control.

Course Outcomes

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

CO1	Explain the requirement for deregulation of the electricity market and the principles of market models in power systems.	Understand
CO2	Investigate the methods of congestion management in deregulated power system.	Analyze
CO3	Evaluate the locational marginal pricing and financial transmission rights.	Apply
CO4	Analyze the ancillary services management.	Analyze
CO5	Distinguish the framework of US and Indian power sectors.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	3	3
CO2	3	2	3	3	3	3
CO3	3	2	3	3	3	3
CO4	3	2	3	3	3	3
CO5	3	2	3	3	3	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		End Sem Examination (Marks)
	1	2	
Remember	10	10	30
Understand	20	20	30
Apply	20	20	30
Analyze	10	10	10
Evaluate	0	0	0
Create	0	0	0

K.S.Rangasamy College of Technology – Autonomous R2022								
60 PPS 204 – Restructured Power System								
M.E-Power Systems Engineering								
Semester	Hours / Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	100
INTRODUCTION Reasons for restructuring - Understanding the restructuring process - objectives of deregulation of various power systems across the world - Consumer behavior - Supplier behavior - Market equilibrium - Short-run and Long-run costs - Various costs of production. The Philosophy of Market Models: Market models based on contractual arrangements - Market architecture.								[9]
TRANSMISSION CONGESTION MANAGEMENT Importance of congestion management in deregulated environment - Classification of congestion management methods - Calculation of ATC - Non-market methods - Market based methods – Nodal pricing - Inter-zonal Intra-zonal congestion management - Price area congestion management - Capacity alleviation method.								[9]
LOCATIONAL MARGINAL PRICES AND FINANCIAL TRANSMISSION RIGHTS Fundamentals of locational marginal pricing - Lossless DCOPF model for LMP calculation – Loss compensated DCOPF model for LMP calculation - ACOPF model for LMP calculation - Risk Hedging Functionality of financial Transmission Rights - FTR issuance process - Treatment of revenue shortfall - Secondary trading of FTRs - Flow Gate rights - FTR and market power.								[9]
ANCILLARY SERVICE MANAGEMENT AND PRICING OF TRANSMISSION NETWORK Types of ancillary services -Load-generation balancing related services - Voltage control and reactive power support services - Black start capability service - Mandatory provision of ancillary services - Markets for ancillary services - Co-optimization of energy and reserve services – International comparison. Pricing of transmission network: wheeling - principles of transmission pricing - transmission pricing methods - Marginal transmission pricing paradigm - Composite pricing paradigm - loss allocation methods.								[9]
MARKET EVOLUTION US markets: PJM market - The Nordic power market - Reforms in Indian power sector: Framework of Indian power sector - Reform initiatives - availability based tariff (ABT) - The Electricity Act 2012 - Open Access issues - Power exchange.								[9]
Total Hours								45
Text Book(s):								
1.	Mohammad Shahidehpour, Muwaffaq Alomoush, “Restructured electrical power systems: operation, trading and volatility” Marcel Dekker Pub.,2001.							
2.	Kankar Bhattacharya, Math H.J.Boolen, and JaapE. Daadler, "Operation of restructured power systems", Kluwer AcademicPub.,2001.							
Reference(s):								
1.	Paranjothi, S.R., “Modern Power Systems The Economics of Restructuring”, New Age International Publishers, First Edition: 2017.							
2.	Sally Hunt, "Making competition work in electricity", John Willey and Sons Inc.2002.							
3.	Steven Stoft," Power System Economics: Designing Markets for Electricity", Wiley-IEEE Press, 2002.							
4.	A. Khaparde, A. R. Abhyankar, "Restructured Power Systems", NPTEL Course, https://nptel.ac.in/courses/108101005/ .							

Course Contents and Lecture Schedule

S.No	Topic	#Hrs
1	Key Issues in Electric Utilities	
1.1	Restructuring Models	1
1.2	Independent System Operator (ISO)	1
1.3	Power Exchange	1
1.4	Market Operations	1
1.5	Market Power	1
1.6	Standard Cost	1
1.7	Transmission Pricing & Congestion Pricing	2
1.8	Management of Inter zonal/Intra zonal Congestion	1
2	Open Access Same-Time Information System (OASIS) & Market Power	
2.1	Introduction	1
2.2	Structure of OASIS	2
2.3	Posting of Information	1
2.4	Transfer capability on OASIS	1
2.5	Market Power - Introduction	1
2.6	Different types of market Power & Mitigation of Market Power - Examples	3
3	Available Transfer Capability (ATC) & Electricity Pricing	
3.1	Introduction	1
3.2	Transfer Capability Issues - ATC, TTC, TRM and CBM Calculations	2
3.3	Calculation of ATC based on power flow	1
3.4	Electricity Pricing - Introduction	1
3.5	Electricity Price Volatility Electricity Price Indexes	1
3.6	Challenges to Electricity Pricing	1
3.7	Construction of Forward Price Curves & Short-time Price Forecasting	2
4	Power System Operation in Competitive Environment	
4.1	Introduction	1
4.2	Operational Planning Activities of ISO	2
4.3	The ISO in Pool Markets	2
4.4	The ISO in Bilateral Markets	2
4.5	Operational Planning Activities of a GENCO	2
5	Transmission Cost Allocation Methods & Ancillary Services Management	
5.1	Introduction	1
5.2	Transmission Cost Allocation Methods	
5.3	Postage Stamp Rate Method	1
5.4	Contract Path Method	1
5.5	MW-Mile Method	1
5.6	Unused Transmission Capacity Method	1
5.7	MVA-Mile method	1
5.9	Comparison of cost allocation methods	1
5.10	Ancillary Services Management - Introduction	1
5.11	Reactive Power as an Ancillary Service - a Review	1
	Total	45

Course DesignersMr.M.Dhanapal - ghanapalm@ksrct.ac.in

Rev.No. 02 / w.e.f. 12.06.2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


 BoS Chairman Signature

60 PPS 2P1	POWER SYSTEM LABORATORY- II	Category	L	T	P	Credit
		PC	0	0	3	2

Objectives

- Solve the power system problems using computational intelligent techniques
- Analyze the solution obtained for power system under normal and abnormal conditions using simulation software
- Expose with real time monitoring of power system
- Evaluate the new techniques used for power system problems with the conventional one.
- Educate to integrate renewable energy sources

Prerequisite

Nil

Course Outcomes

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

CO1	Apply advanced tools to simulate the model of power network for power system problems	Apply
CO2	Acquire expertise in usage of modern techniques for Power System Issues	Apply
CO3	Apply soft computing techniques to Power System problems and evaluate the solution	Apply
CO4	Analyze the solution obtained through soft computing techniques	Analyze
CO5	Suggest suitable technique as applicable to power system problem	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	3	3
CO2	3	3	3	2	3	3
CO3	3	3	3	2	3	3
CO4	3	3	3	2	3	3
CO5	3	3	3	2	3	3

List of Experiments

1. AC-DC power flow analysis
2. Application of neural networks to load forecasting and contingency analysis
3. Solution of Unit commitment Problem through Evolutionary algorithm
4. Solution of Economic Dispatch using Evolutionary algorithm
5. Automatic Voltage Regulator with Power System Stabilizer
6. Study of Relay Coordination
7. Simulation of Solar PV & Wind Energy Conversion System
8. Intelligent control techniques for Automatic Generation Control
9. Soft Computing Techniques for Power System Problems
10. State Estimation of Power System
11. Analysis of Power grid in presence of Renewable Energy Sources

Course Designers :

Dr.T.Venkatesan venkatesan@ksrct.ac.in

PROFESSIONAL ELECTIVE (PE) SEMESTER II, PROFESSIONAL ELECTIVE

Rev.No. 02 / w.e.f. 12.06.2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

60 PPS E11	Distributed Energy Resources and Microgrid	Category	L	T	P	Credit
		PE	3	0	0	3

Objective

- To identify the distributed energy resources.
- To illustrates the concept of distributed generation.
- To Analyze the impact of grid integration.
- To study the concept of micro grid and its configuration.
- To illustrate the control and operation of microgrid.

Prerequisite

NIL

Course Outcomes

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

CO1	Apply the current scenario of Distributed Generation and the need to implement DG sources	Apply
CO2	Associate different types of micro-grids and Investigate the different types of interfaces for Grid integration of DGs	Analyze
CO3	Evaluate the various impacts of DGs on system performance and analysis of stability	Understand
CO4	Appraise and evaluate the reactive power and voltage control of DGs and various control aspects upon transmission and distribution systems.	Analyze
CO5	Analyse the islanding schemes and protection related issues in micro-grids.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	2	2	1	1
CO2	3	3	2	2	1	1
CO3	2	2	2	1	1	3
CO4	2	2	2	2	2	2
CO5	3	2	2	2	-	1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests(Marks)		End Sem Examination(Marks)
	1	2	
Remember	10	10	20
Understand	20	30	30
Apply	20	10	30
Analyse	0	0	10
Evaluate	10	10	10
Create	0	0	0

K.S.Rangasamy College of Technology – Autonomous R2022								
60 PPS E11 - Distributed Energy Resources and Microgrid								
M.E. Power Systems Engineering								
Professional Elective								
Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	100
Micro-grids Concept and definition of micro-grid, micro-grid drivers and benefits, review of sources of micro-grids, typical structure and configuration of a micro-grid, AC and DC micro-grids, Power Electronics interfaces in DC and AC micro-grids								[09]
Distributed Generation (DG) Need for distributed generation, renewable sources in distributed generation, current scenario in distributed generation, planning of DGs – Siting and sizing of DGs, optimal placement of DG sources in distribution systems.								[09]
Grid integration of DGs Requirements for grid interconnection, limits on operational parameters, different types of interfaces - Inverter based DGs and rotating machine based interfaces, aggregation of multiple DG units, Energy storage elements- Batteries, ultra capacitors, flywheels, Technical impacts of DGs – Transmission systems, Distribution systems, Impact of DGs on protective relaying, Impact of DGs on transient and dynamic stability of existing distribution systems.								[12]
Economic and control aspects of DGs Market facts, issues and challenges, limitations of DGs, Voltage control techniques, Reactive power control, Harmonics, Power quality issues, Steady-state and Dynamic analysis, Different types of restoration systems.								[08]
Modes of operation and control of microgrid grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques								[07]
Total Hours								45
TextBook(s):								
1.	AmirnaserYezdani, and Reza Iravani, “Voltage Source Converters in Power Systems: Modeling, Control and Applications”, IEEE John Wiley Publications. 2009.							
2	DorinNeacsu, “Power Switching Converters: Medium and High Power”, CRC Press, Taylor & Francis, 2006.							
Reference(s):								
1.	H. Lee Willis, Walter G. Scott, 'Distributed Power Generation – Planning and Evaluation', Marcel Decker Press, 2000. Electrical Engineering Department, National Institute of Technology Kurukshetra 20							
2.	M. Godoy Simoes, Felix A. Farret, 'Renewable Energy Systems – Design and Analysis with Induction							
3.	Robert Lasseter, Paolo Piagi, 'Micro-grid: A Conceptual Solution', PESC 2004, June 2004							
4.	F. Katiraei, M.R. Iravani, 'Transients of a Micro-Grid System with Multiple Distributed Energy Resources', International Conference on Power Systems Transients (IPST'05) in Montreal, Canada on June 19-23, 2005							

Rev.No. 02 / w.e.f. 12.06.2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

Course Contents and Lecture Schedule

S.No	Topic	#Hrs
1	Microgrids	
1.1	Concept and definition of microgrid	1
1.2	Microgrid drivers and benefits	1
1.3	review of sources of microgrids	2
1.4	typical structure and configuration of a microgrid,	2
1.5	AC and DC microgrids, Power Electronics interfaces in DC and AC microgrids	1
1.6	Power Electronics interfaces in DC microgrids	1
1.7	Power Electronics interfaces in AC microgrids	1
2	Distributed Generation (DG)	
2.1	Need for distributed generation	1
2.2	Renewable sources in distributed generation	2
2.3	Current scenario in distributed generation	1
2.4	Planning of DGs	1
2.5	Siting of DGs	1
2.6	Sizing of DGs	1
2.7	Optimal placement of DG sources in distribution systems.	2
3	Grid integration of DGs	
3.1	Requirements for grid interconnection	1
3.2	Limits on operational parameters,	1
3.3	Types of interfaces	1
3.4	Inverter based DGs and rotating machine based interfaces	2
3.5	Aggregation of multiple DG units	2
3.6	Energy storage elements- Batteries, ultra capacitors, flywheels	1
3.7	Technical impacts of DGs – Transmission systems, Distribution systems	2
3.8	Impact of DGs on protective relaying.	1
3.9	Impact of DGs on transient stability	1
3.10	Impact of DGs on dynamic stability of existing distribution systems	1
4	Economic and control aspects of DGs	
4.1	Market facts, issues and challenges, Limitations of DGs	1
4.3	Voltage control techniques	2
4.4	Reactive power control	1
4.5	Harmonics, Power quality issues	2
4.6	Steady-state and Dynamic analysis	1
4.7	Different types of restoration systems	1
5	Modes of operation and control of microgrid	
5.1	Grid connected and islanded mode	1
5.2	Active and reactive power control	2
5.3	Protection issues	1
5.4	Anti-islanding schemes: passive, active	1
5.5	Communication based techniques	2
	Total	45

Course DesignersMr. E. Chandra kumar - chandrakumar@ksrct.ac.in

Category	L	T	P	Credit
----------	---	---	---	--------

Rev.No. 02 / w.e.f. 12.06.2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


 BoS Chairman Signature

60 PPS E12	Optimization Techniques to Power System Engineering
-------------------	--

PE	3	0	0	3
----	---	---	---	---

Objective

- To Understand The Concepts Of Economic Load Dispatch, Emission Load Dispatch And Optimal Hydrothermal Scheduling Of Power System.
- To Learn The Different Classical And Intelligent Optimization Methods To Solve Power System Problems.
- To Learn The Efficient Methods Of Problem Solving For Load Dispatch And Hydro Thermal Scheduling And Active And Reactive Power Balance.
- To Understand The Multi-Objective Optimization Methods In Power System Problem Solving.
- To Understand Novel Backward–Forward Sweep (BFS)-Based Methodology For Optimal Allocation Of DG Micro-Plants In Radial Distribution Systems

Prerequisite

NIL

Course Outcomes

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

CO1	Modeling of hydro, thermal or hybrid power system.	Apply
CO2	Explain the concept of load dispatch, hydrothermal scheduling problems and classical and intelligent solution.	Understand
CO3	Solve single or multi optimization of power systems like cost and emission or both in a thermal or hydro thermal power system..	Analyse
CO4	Analyze operation and control of hydro thermal power systems	Analyze
CO5	Implement backward–forward sweep aiming to minimize total real power losses	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	2	2
CO2	3	3	2	2	2	2
CO3	3	3	2	2	2	2
CO4	2	2	2	2	2	2
CO5	2	3	2	2	2	2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests(Marks)		End Sem Examination(Marks)
	1	2	
Remember	10	20	30
Understand	20	10	10
Apply	30	10	30
Analyse	0	20	30
Evaluate	0	0	0
Create	0	0	0

K.S.Rangasamy College of Technology – Autonomous R2022								
60 PPS E12 - Optimization Techniques to Power System Engineering								
Power Systems Engineering								
Professional Elective								
Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P			CA	ES	Total
II	3	0	0	45	3	40	60	100
Economic Load Dispatch of thermal Generating Units: Introduction, Generator operating cost, Economic Dispatch problem on a bus bar, Optimal generation scheduling, Economic dispatch using Newton-Raphson method, Economic dispatch using the approximate Newton-Raphson method, Economic dispatch using efficient method, Function of generation & loads.								[9]
Optimal Hydro thermal Scheduling: Introduction, Hydro plant performance Models, Short Range Fixed-Head Hydro thermal Scheduling, Newton-Raphson for short-range fixed –head hydro thermal scheduling, Approximate Newton-Raphson method for short –range fixed-head hydro thermal Scheduling, Short-Range variable-head hydro thermal scheduling-Classical Method, Approximate Newton-Raphson method for short -range variable-head hydro thermal scheduling, Hydro plant modeling for long term operation, Long-Range generation scheduling of hydro thermal systems.								[9]
Multi-Objective Generation Scheduling: Introduction, Multi objective optimization- State of the art, Fuzzy set theory in power system, the surrogate worth trade of approach for multi objective thermal power dispatch problem, multi objective thermal power dispatch- weighing method, multi objective dispatch for active & reactive power balance.								[9]
Stochastic Multi Objective Generation Scheduling: Introduction, multi-objective stochastic optimal thermal power dispatch- □ -constant method, multi-objective stochastic optimal thermal power dispatch-The surrogate worth trade-off method, multi-objective stochastic optimal thermal power dispatch-weighting method, stochastic economic-emission load dispatch, multi-objective optimal thermal dispatch-risk/dispersion method, stochastic multi-objective short term hydro thermal scheduling, stochastic multi - objective long-term hydro thermal scheduling.								[9]
A Novel Forward-Backward Sweep Based Optimal DG Placement Approach in Radial Distribution Systems. Motivation and Literature Review-Comparison between different algorithms proposed for solving optimal DG placement problem-Optimal DG allocation problem-Algorithm and Illustration.								
Total Hours								45
Text Book(s):								
1.	Kothari D.P, Dhillon J.S, “Power System Optimization” – PHI Private Limited.							
2	JJames A Momoh, “Electric Power System Application of Optimization”, CRC Press							
Reference Book(s):								
1.	S.S. Rao, “Engineering Optimization-Theory and Practice Power”, 2009 John Wiley & Sons, New York, USA.							
2.	A.D. Belegundu, T.R. Chandrupatla, “Optimization Concepts and Applications in Engineering”, Cambridge, University press							
3.	Mahmoud Pesaran Hajiabbas, Behnam Mohammadi-Ivatloo “Optimization of Power System Problems” Studies in Systems, Decision and Control, Volume 262,2020, Springer. ISSN 2198-4182 ISSN 2198-4190. http://www.springer.com/series/13304							
4.	Saxena, N.K.: Investigation of static and dynamic reactive power compensation and cost analysis in isolated hybrid power system. Unpublished doctoral dissertation, Electrical Engineering Department, National Institute of Technology, Kurukshetra, India (2016)							

Course Contents and Lecture Schedule

Rev.No. 02 / w.e.f. 12.06.2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


 BoS Chairman Signature

S.No	Topic	#Hrs
1	Economic Load Dispatch of thermal Generating Units	
1.1	Introduction,	1
1.2	Generator operating cost,	1
1.3	Economic Dispatch problem on a bus bar,	1
1.4	Optimal generation scheduling,	1
1.5	Economic dispatch using Newton-Raphson method,	2
1.6	Economic dispatch using the approximate Newton-Raphson method,	1
1.7	Economic dispatch using efficient method & Function of generation & loads.	2
2	Optimal Hydro thermal Scheduling:	
2.1	Introduction	1
2.2	Hydro plant performance Models	1
2.3	Short Range Fixed-Head Hydro thermal Scheduling	1
2.4	Newton-Raphson for short-range fixed –head hydro thermal scheduling,–	1
2.5	Approximate Newton-Raphson method for short range fixed-head hydro thermal Scheduling,	1
2.6	Short-Range variable-head hydro thermal scheduling-Classical Method,	1
2.7	Approximate Newton-Raphson method for short -range variable-head hydro thermal scheduling,	1
2.8	Hydro plant modeling for long term operation,	1
2.9	Long-Range generation scheduling of hydro thermal systems.	1
3	Multi-Objective Generation Scheduling:	
3.1	Introduction & Multi objective optimization- State of the art	2
3.1	Fuzzy set theory in power system,	2
3.2	Trade of approach for multi objective thermal power dispatch problem,	2
3.3	Multi objective thermal power dispatch- weighing method,	2
3.4	Multi objective dispatch for active & reactive power balance.	1
4	Stochastic Multi Objective Generation Scheduling:	
4.1	Introduction,	1
4.2	Multi-objective stochastic optimal thermal power dispatch- □ -constant method,	1
4.3	Multi-objective stochastic optimal thermal power dispatch-	1
4.4	The surrogate worth trade-off method, multi-objective stochastic	1
4.5	Optimal thermal power dispatch- weighing method,	1
4.6	Stochastic economic-emission load dispatch,	1
4.7	Multi objective optimal thermal dispatch- risk/dispersion method,	1
4.8	Stochastic multi-objective short term hydro thermal scheduling,	1
4.9	Stochastic multi -objective long-term hydro thermal scheduling.	1
5	A Novel Forward-Backward Sweep Based Optimal DG Placement Approach in Radial Distribution Systems.	
5.1	Motivation and Literature Review	3
5.2	Comparison between different algorithms proposed for solving optimal DG placement problem-	3
5.3	Optimal DG allocation problem-Algorithm and Illustration.	3
	Total	45

Course Designers

Dr.D.SriVidhya

- srividhya@ksrct.ac.in

60 PPS E13	Wind Energy Conversion System Design	Category	L	T	P	Credit
		PE	3	0	0	3

Rev.No. 02 / w.e.f. 12.06.2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

Objective

- To understand the fundamentals of wind energy and its conversion system
- To understand the aerodynamics theory related to wind turbine types
- To learn gear coupled generator wind turbine components
- To analyze the grid integration and related issues with direct drive generators.
- To learn modern wind turbine control & monitoring

Prerequisite

Renewable Energy sources

Course Outcomes

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

CO1	Acquire Knowledge in conversion techniques of wind energy and Wind Measurements.	Understand
CO2	Design the wind turbine components and their construction.	Apply
CO3	Identify the types of wind generator and Turbine for various applications.	Understand
CO4	Acquire Knowledge of Variable speed wind generator and Turbine.	Apply
CO5	Discuss the modern wind turbine control & monitoring.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	2
CO2	3	3	2	2	2	2
CO3	3	3	3	2	2	2
CO4	3	3	3	2	2	2
CO5	3	3	3	2	2	2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		End Sem Examination(Marks)
	1	2	
Remember	10	20	30
Understand	20	30	30
Apply	30	10	30
Analyse	0	0	10
Evaluate	0	0	0
Create	0	0	0

K.S.Rangasamy College of Technology–Autonomous R2022								
60 PPS E13 – Wind Energy Conversion System Design								
M.E. Power Systems Engineering								
Professional Elective								
Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
I	3	0	0	45	3	40	60	100
Wind Energy Fundamentals & Wind Measurements Wind Energy Basics - Wind Speeds and scales-Terrain – Roughness - Wind Mechanics – Power Content-Class of wind turbines - Atmospheric Boundary Layers - Turbulence. Instrumentation for wind Measurements – Wind data analysis–tabulation-Wind resource estimation-Betz’s Limit–								8
Aerodynamics Theory & Wind Turbine Types Airfoil terminology - Blade element theory - Blade design - Rotor performance and dynamics - Balancing technique (Rotor&Blade). Types of loads – Sources of loads – Vertical Axis Type –Horizontal Axis-Constant Speed Constant Frequency - Variable speed Variable Frequency - Up Wind - Down Wind - Stall Control - Pitch Control – Gear Coupled Generator type - Direct Generator Drive – PMG - Rotor Excited								10
Gear Coupled Generator Wind Turbine Components and their Construction Electronics Sensors; Encoder, Resolvers – Wind Measurement – Anemometer & Wind Vane–Grid Synchronisation System – Soft Starter –Switchgear [ACB/VCB] – Transformer – Cables and assembly-Compensation Panel – Programmable Logic Control - UPS. Yaw & Pitch System: AC Drives–Safety Chain Circuits - Generator Rotor Resistor controller (Flexi Slip) - Differential Protection Relay for Generator - Battery –Super Capacitor Charger & Batteries - Super Capacitor for Pitch System- Transient Suppressor - Lightning Arrestors –Oscillation &Vibration sensing.								10
Direct Rotor Coupled Generator-Multipole&Variable Speed Variable Frequency Excited Rotor Synchronous Generator - PMG Generator - Control Rectifier - Capacitor Banks - Step Up – Boost Converter (DC-DC StepUp) – Grid Tied Inverter - Power Management - Grid Monitoring Unit (Voltage and Current) – Transformer - Safety Chain Circuits.								8
Modern Wind Turbine Control & Monitoring System Details of Pitch System & Control Algorithms - Protections used & Safety Consideration in Wind Turbines – Wind Turbine Monitoring with Error codes- CADA & Databases: Remote Monitoring and Generation Operation&Maintenance for Product Life Cycle-Balancing technique(Rotor&Blade)-FACTS control&LVRT- New trends for new Grid Codes								9
Total Hours								45
Textbook(s):								
1.	Mario Garcia–Sanz, Constantine H. Houppis, “Wind Energy Systems”, CRC Press, 2012..							
2.	J.K.Kaldellis, “Stand–alone and Hybrid Wind Energy Systems”, CRC Press, 2010.							
Reference(s):								
1.	L.L.Freris, “Wind Energy Conversion Systems”, Prentice Hall, 1990							
2.	Erich Hau, “Wind Turbines: Fundamentals, Technologies, Application, Economics“, Horst von Renouard, 2011.							
3.	John D Sorensen and Jens N Sorensen, “Wind Energy Systems”, Woodhead Publishing Ltd, 2011.							
4.	Twidell, J.W. and Weir, A., “Renewable Energy Sources”, EFN Spon Ltd., 2015.							

Rev.No. 02 / w.e.f. 12.06.2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

Course Contents and Lecture Schedule

S.No	Topic	#Hrs
1	Wind Energy Fundamentals & Wind Measurements	
1.1	Wind Energy Basics	1
1.2	Wind Speeds and scales	1
1.3	Terrain – Roughness & Wind Mechanics	2
1.5	Power Content-Class of wind turbines & Atmospheric Boundary Layers	2
1.7	Turbulence. Instrumentation for wind Measurements	1
1.8	Tabulation Wind resource estimation-Betz's Limit-Turbulence Analysis	1
2	Aero dynamics Theory & Wind Turbine Types	
2.1	Airfoil terminology - Blade element theory - Blade design	1
2.2	Rotor performance and dynamics - Balancing technique(Rotor & Blade)	1
2.3	Types of loads-Sources of loads-Vertical Axis Type	1
2.4	Horizontal Axis-Constant Speed Constant Frequency	1
2.5	Variable speed Variable Frequency	1
2.6	Up Wind - Down Wind - Stall Control - Pitch Control	1
2.7	Gear Coupled Generator type	1
2.8	Direct Generator Drive, PMG & Rotor Excited Sync Generator	3
3	Gear Coupled Generator Wind Turbine Components and their Construction	
3.1	Electronics Sensors; Encoder, Resolvers-Wind Measurement	1
3.2	Anemometer & Wind Vane-Grid Synchronization System	1
3.3	Soft Starter-Switchgear[ACB/VCB]-Transformer-Cables and assembly	1
3.4	Compensation Panel-Programmable Logic Control	1
3.5	Yaw & Pitch System	1
3.6	Generator Rotor Resistor controller (Flexi Slip)	1
3.7	Differential Protection Relay for Generator - Battery	1
3.8	Super Capacitor Charger & Batteries - Super Capacitor for Pitch System	1
3.9	Transient Suppressor - Lightning Arrestors	1
3.10	Oscillation & Vibration sensing	1
4	Direct Rotor Coupled Generator Multi pole & Variable Speed Variable Frequency	
4.1	Excited Rotor Synchronous Generator & PMG Generator - Control Rectifier	2
4.2	Capacitor Banks & Boost Converter(DC-DC Step Up)	2
4.3	Grid Tied Inverter-Power Management &	2
4.4	Grid Monitoring Unit (Voltage and Current) & Transformer & Safety Chain Circuits	2
5	Modern Wind Turbine Control & Monitoring System	
5.1	Details of Pitch System & Control Algorithms	1
5.2	Protections used & Safety Consideration in Wind Turbines	1
5.3	Wind Turbine Monitoring with Error codes	1
5.4	Remote Monitoring and Generation Reports Operation	1
5.5	Maintenance for Product Life Cycle	1
5.6	Balancing technique (Rotor & Blade)	1
5.7	FACTS control & LVRT	1
5.8	New trends for new Grid Codes	1
	Total	45

Course Designers

R.Radhamani

- radhamani@ksrct.ac.in

Rev.No. 02 / w.e.f. 12.06.2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


 BoS Chairman Signature

60 PPS E14	IoT for Smart Systems	Category	L	T	P	Credit
		PE	3	0	0	3

Objective

- Recognize the concepts of IoT and its present developments
- Compare and contrast different platforms and infrastructures available for IoT
- Explain different protocols and communication technologies used in IoT
- Explore the big data analytics and programming of IoT with smart applications
- Apprehend the various energy sources and energy harvesting based sensor networks

Prerequisite

Microprocessors & Microcontrollers, Embedded Systems

Course Outcomes

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

CO1	Recognize the concepts of IoT and its present developments	Understand
CO2	Compare and contrast different platforms and infrastructures available for IoT	Analyze
CO3	Explain different protocols and communication technologies used in IoT	Understand
CO4	Explore the big data analytics and programming of IoT with smart applications	Apply
CO5	Apprehend the various energy sources and energy harvesting based sensor networks	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	3	2
CO2	3	2	3	2	3	2
CO3	3	2	3	2	3	2
CO4	3	2	2	2	3	2
CO5	2	3	2	2	3	2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests(Marks)		End Sem Examination(Marks)
	1	2	
Remember	10	20	30
Understand	20	20	30
Apply	20	10	30
Analyse	10	10	10
Evaluate	0	0	0
Create	0	0	0

K.S.Rangasamy College of Technology – Autonomous R2022								
60 PPS E14 - IoT for Smart Systems								
M.E -Power Systems Engineering								
Professional Elective								
Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	100
INTRODUCTION TO INTERNET OF THINGS Overview - Hardware and software requirements for IoT- Sensor and actuators - Technology drivers - Business drivers - Typical IoT applications - Trends and implications								[9]
IOT ARCHITECTURE IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture , IoT standards, Cloud computing for IoT ,Bluetooth, Bluetooth Low Energy, beacons.								[9]
PROTOCOLS & WIRELESS TECHNOLOGIES FOR IOT NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell. WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends.								[9]
EMBEDDED PROCESSORS FOR IOT & ITS APPLICATIONS Services/Attributes: Big-Data Analytics for IoT, Dependability, Interoperability, Security, Maintainability. Introduction to Python programming -Building IoT with RASPERRY PI and Arduino. Case study on Smart Grid, Connected Vehicles, Electric Vehicle Charging.								[9]
ENERGY HARVESTING SYSTEMS Introduction – Energy sources – energy harvesting based sensor networks – photovoltaic cell technologies – generation of electric power in semiconductor PV cells – types								[9]
Total Hours								45
Text Book(s):								
1.	Oliver Hersent , David Boswarthick and Omar Elloumi “ The Internet of Things”, Wiley,2016.							
2	ArshdeepBahga and Vijai Madiseti : A Hands-on Approach “Internet of Things”, Universities Press 2015.							
Reference(s):								
1.	Danick Briand, Eric Yeatman, Shad Roundy ,“Micro Energy Harvesting” Wiley VCH ,April 2015							
2.	Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley and sons, 2014.							
3.	Jean- Philippe Vasseur, Adam Dunkels, “Interconnecting Smart Objects with IP: The Next Internet” Morgan Kuffmann Publishers, 2010.							
4.	Upena Dalal,“Wireless Communications & Networks, Oxford, 2015.							

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

Course Contents and Lecture Schedule

S.No	Topic	#Hrs
1	INTRODUCTION TO INTERNET OF THINGS	
1.1	IoT : Overview	1
1.2	Hardware requirements for IoT	1
1.3	Software requirements for IoT	1
1.4	Sensor and actuators	1
1.5	Technology drivers	1
1.6	Business drivers	1
1.7	Typical IoT applications	2
1.8	Trends and implications	1
2	IOT ARCHITECTURE	
2.1	IoT reference model and architecture	1
2.2	Node Structure	1
2.3	Sensing, Processing, Communication	1
2.4	Networking Topologies	1
2.5	Layer/Stack architecture	1
2.6	IoT standards	1
2.7	Cloud computing for IoT	1
2.8	Bluetooth	1
2.9	Bluetooth Low Energy & beacons.	1
3	PROTOCOLS & WIRELESS TECHNOLOGIES FOR IOT	
3.1	NFC, SCADA and RFID	1
3.2	Zigbee MIPI, M-PHY	1
3.3	Communication Technologies	1
3.4	WiFi (IEEE 802.11)	1
3.5	Bluetooth/Bluetooth Smart	1
3.6	ZigBee / ZigBee Smart	1
3.7	UWB (IEEE 802.15.4)	1
3.8	6LoWPAN	1
3.9	Proprietary systems & Recent trends	1
4	EMBEDDED PROCESSORS FOR IOT & ITS APPLICATIONS	
4.1	Big-Data Analytics for IoT	1
4.2	Services & Attributes	1
4.3	Introduction to Python programming	2
4.4	Building IoT with RASPBERRY PI	2
4.5	Building IoT with Arduino	2
4.6	Case Study	1
5	ENERGY HARVESTING SYSTEMS	
5.1	Introduction	1
5.2	Energy sources	2
5.3	Energy harvesting based sensor networks	2
5.4	Photovoltaic cell technologies	2
5.5	Types of PV	2
	Total	45

Course Designer : T. Prabhu, AP/EEE

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

60 PPS E15	High Voltage Technology	Category	L	T	P	Credit
		PE	3	0	0	3

Objective

- To provide strong knowledge on different types of electrical stresses on power system and equipment
- To impart knowledge on generation of high AC and DC voltages
- To provide adequate knowledge to simulate and generate impulse voltages and impulse currents.
- To expose the different techniques of measuring High voltages and high currents
- To provide awareness on electro-static hazards and safety measures

Prerequisite

Power System

Course Outcomes

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

CO1	Analyze the generating circuits for generation of high DC voltages.	Analyse
CO2	Analyze the generating circuits for generation of high AC voltages.	Analyse
CO3	Realize the various methods to generate the impulse voltage and current	Analyse
CO4	Analyze the measuring circuits and techniques for the measurement of high Voltages and currents	Analyse
CO5	Realize the philosophy of electrostatic hazards and develop procedures for safety measurers.	Analyse

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	-	3
CO2	3	3	3	2	-	3
CO3	3	3	3	2	-	3
CO4	3	3	-	1	-	-
CO5	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Sem Examination
	1	2	
Remember	40	40	40
Understand	30	30	30
Apply	30	30	30
Analyse	0	0	0
Evaluate	0	0	0
Create	0	0	0

Rev.No. 02 / w.e.f. 12/06/2023
 Passed in BoS Meeting held on 13/05/2023
 Approved in Academic Council Meeting held on 03/06/2023


 BoS Chairman Signature

K.S.Rangasamy College of Technology – Autonomous R2018								
60 PPS E15 – High Voltage Technology								
M.E POWER SYSTEMS ENGINEERING								
Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
	3	0	0	45	3	40	60	100
GENERATION OF DIRECT VOLTAGES Requirements of HV generation in Laboratory, voltage stress, testing voltages, generation of direct voltages – AC to DC conversion – single phase rectifier circuits – cascade circuits –Voltage multiplier circuits – Cockcroft-Walton circuit – voltage regulation –ripple-factor – Electrostatic generators.								[9]
GENERATION OF ALTERNATING VOLTAGE Testing transformer – single unit testing transformer, cascaded transformer – equivalent circuit of cascaded transformer –resonant circuits – resonant transformer – voltage regulation.								[9]
GENERATION OF IMPULSE VOLTAGES AND CURRENTS Impulse voltage, general shape and definition of lightning impulses, generator circuit – Marx generator –analysis of various impulse voltage generator circuits, controlled switching – multistage impulse generator circuits – Switching impulse generator circuits – Generation of impulse currents, generation of non- standard impulse voltages and very fast transient voltage (VFTO)- Relevant IS and IEC Standards								[9]
MEASURMENT OF HIGH VOLTAGES Measurement of high AC, DC Impulse voltages - Peak voltage measurements by sphere gaps – Electrostatic voltmeter – generating voltmeters and field sensors – Chubb-Fortescue method – voltage dividers, types, dynamic response and impulse voltage measurements- Relevant IS and IEC Standards, measurement of high DC, AC and impulse currents – shunts, measurement using magnetic potentiometers and magnetic coupling - Fast digital transient recorders for impulse measurements								[9]
SAFETY AND ELECTROSTATIC HAZARDS Introduction – Nature of static electricity – Triboelectric series – Basic laws of Electrostatic electricity– materials and static electricity – Electrostatic discharges (ESD) – Static electricity problems – Hazards of Electrostatic electricity in industry – Hazards from electrical equipment and installations – Static eliminators and charge neutralizers – Lightning protection- safety measures and standards								[9]
Total Hours								45
Text book(s):								
1.	M. S. Naidu and V. Kamaraju, High Voltage Engineering, 5th Edition Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2013.							
2.	L.L.Alston, High Voltage Technology, Oxford University Press, First Indian Edition 2011.							
Reference(s):								
1.	E.Kuffel and W.S. Zaengl, J.Kuffel, High voltage Engineering fundamentals, Newnes Second Edition ,Elsevier , New Delhi 2005.							
2.	Rakosh Das Begamudre, High Voltage Engineering, Problems and Solutions, New Age International Publishers, New Delhi, 2010							
3.	C.L.Wadhwa, High voltage Engineering, New Age International Publishers, Third Edition,2010.							
4.	R.Mazen Abdel-Salam, Hussein Anis, Ahdab El-Morshedy, RoshdyRadwan, “High Voltage Engineering Theory and Practice” Second Edition, Revised and Expanded, Marcel Dekker,Inc., New York, 2000.							

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

Course Content and Lecture Schedule

S.No.	Topic	# Hrs
1	GENERATION OF DIRECT VOLTAGES	
1.1	Requirements of HV generation in Laboratory	1
1.2	Voltage stress, testing voltages, generation of direct voltages	1
1.3	AC to DC conversion	1
1.4	single phase rectifier circuits	1
1.5	cascade circuits	1
1.6	Voltage multiplier circuits	2
1.7	Cockcroft-Walton circuit, voltage regulation, ripple-factor	1
1.8	Electrostatic generators	1
2	GENERATION OF ALTERNATING VOLTAGE	
2.1	Testing transformer	1
2.2	Single unit testing transformer	2
2.3	Cascaded transformer	2
2.4	Equivalent circuit of cascaded transformer	1
2.5	Resonant circuits	1
2.6	Resonant transformer	1
2.7	Voltage regulation	1
3	GENERATION OF IMPULSE VOLTAGES AND CURRENTS	
3.1	Impulse voltage, general shape and definition of lightning impulses generator circuit	2
3.2	Marx generator, analysis of various impulse voltage generator circuits	1
3.3	Controlled switching	1
3.4	Multistage impulse generator circuits	1
3.5	Switching impulse generator circuits	1
3.6	Generation of impulse currents, generation of non- standard impulse voltages and very fast transient voltage (VFTO)	2
3.7	Relevant IS and IEC Standards	1
4	MEASUREMENT OF HIGH VOLTAGES	
4.1	Measurement of high AC, DC Impulse voltages	1
4.2	Peak voltage measurements by sphere gaps	1
4.3	Electrostatic voltmeter – generating voltmeters and field sensors	1
4.4	Chubb-Fortescue method	1
4.5	Voltage dividers, types, dynamic response and impulse voltage measurements	1
4.6	Relevant IS and IEC Standards	1
4.7	Measurement of high DC, AC and impulse currents	1
4.8	Shunts, measurement using magnetic potentiometers and magnetic coupling	1
4.9	Fast digital transient recorders for impulse measurements	1
5	SAFETY AND ELECTROSTATIC HAZARDS	
5.1	Introduction – Nature of static electricity, Triboelectric series	1
5.2	Basic laws of Electrostatic electricity	1
5.3	materials and static electricity	1
5.4	Electrostatic discharges (ESD)	1
5.5	Static electricity problems	1
5.6	Hazards of Electrostatic electricity in industry	1
5.7	Hazards from electrical equipment and installations	1
5.8	Static eliminators and charge neutralizers	1
5.9	Lightning protection- safety measures and standards	1

Course Designers N.Kayalvizhi – kayalvizhi@ksrct.ac.in

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

SEMESTER II, PROFESSIONAL ELECTIVE II

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	60 PPS E21	Power Quality Engineering	PE	3	3	0	0	3
2.	60 PPS E22	Solar and Energy Storage Systems	PE	3	3	0	0	3
3.	60 PPS E23	PWM Techniques and its Applications	PE	3	3	0	0	3
4.	60 PPS E24	EHV AC Transmission	PE	3	3	0	0	3
5.	60 PPS E25	Machine Learning and Deep Learning System	PE	3	3	0	0	3

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

60 PPS E21	Power Quality Engineering	Category	L	T	P	Credit
		PE	3	0	0	3

Objective

- To Review definitions and standards of common power quality phenomena.
- To identify the harmonics and its Effects on various equipments
- To explain the effects of Electromagnetic Interference
- To acquire knowledge on compensation techniques
- To gain knowledge on power quality monitoring

Prerequisite

Power Electronics

Course Outcomes

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

CO1	Classify power quality issues in a power system	Apply
CO2	Various types of Harmonics their causes and effects on Power System.	Understand
CO3	The Concept of Electromagnetic Interference and its impacts Power Quality and Power System.	Understand
CO4	Understand the filter design to mitigate power quality issues	Analyze
CO5	Develop practical skills and analyzing the results for power quality and condition monitoring testing.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	2	2
CO2	3	3	2	3	2	3
CO3	3	3	2	2	2	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests(Marks)		End Sem Examination(Marks)
	1	2	
Remember	10	10	10
Understand	20	30	30
Apply	30	20	30
Analyse	0	0	30
Evaluate	0	0	0
Create	0	0	0

K.S.Rangasamy College of Technology – Autonomous R2022								
60 PPS E21 -Power Quality Engineering								
M.E POWER SYSTEMS ENGINEERING								
Professional Elective - II								
Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	100
INTRODUCTION Introduction – Characterization of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves – power quality problems: poor load power factor, Non-linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage.								[9]
HARMONICS Harmonic distortion standards, power system quantities under non sinusoidal conditions-harmonic indices-source of harmonics-system response characteristics. Effect of power system harmonics on power system equipment and loads. –principles for controlling harmonics, reducing harmonic currents in loads, filtering, modifying the system frequency response- Devices for controlling harmonic distortion, inline reactors or chokes, zigzag transformers, passive filters, active filters.								[9]
ELECTROMAGNETIC INTERFERENCE Introduction to EMI - Frequency Classification - Electrical Fields - Magnetic Fields - EMI Terminology - Power Frequency Fields - High Frequency Interference - EMI Susceptibility - EMI Mitigation - Health Concerns of EMI.								[9]
POWER QUALITY CONDITIONERS Shunt and series compensators, Distribution STATCOMS (DSTATCOMS) and Dynamic Voltage Restorers (DVRs), Rectifier supported DVR, DC Capacitor supported DVR, DVR Structure, Voltage Restoration – Series Active Filter – Unified power quality conditioners. Sensors and measurement techniques, traditional and advanced diagnostic methods, Case studies and real-time tests.								[9]
POWER QUALITY MONITORING Monitoring consideration - power quality measurement equipment - assessment of power quality measurement data - application of intelligent system - power quality monitoring standards. Power quality monitoring and analysis. Case study for 220/110 kV substation, DSP-based solutions for electric power industry - Power Quality Monitoring and Analysis of the Domestic Grids, Analysis of voltage dips in power system.								[9]
Total Hours								45
Text Book(s):								
1.	Ghosh Arindam and Ledwich Gerard, ‘Power quality enhancement using custom power devices’ Springer. First edition 2002.							
2	R.C.Duggan “Electric Power Systems Quality”, Tata MC Graw Hill Publishers, Third Edition, 2012.							
Reference(s):								
1.	Arrillaga J., Watson N. R. and Chen S., ‘Power System Quality Assessment’ Wiley. January 2000							
2.	Caramia P, Carpinelli G and Verde P, ‘Power quality indices in liberalized markets’ – Wiley, September 2009							
3.	Angelo Bagгинi ‘Handbook of Power Quality’ – Wiley. First published:18 April 2008							
4.	G.T.Heydt, “Electric Power Quality”, Stars in a Circle Publications, 1994(2nd edition)							

Course Contents and Lecture Schedule

S.No	Topic	#Hrs
1	INTRODUCTION	
1.1	Introduction – Characterization of Electric Power Quality	1
1.2	Transients, short duration and long duration voltage variations	1
1.3	Voltage imbalance, waveform distortion, Voltage fluctuations	1
1.4	Power frequency variation, Power acceptability curves	2
1.5	power quality problems: poor load power factor	1
1.6	Non-linear and unbalanced loads, DC offset in loads	1
1.7	Notching in load voltage	1
1.8	Disturbance in supply voltage	1
2	HARMONICS	
2.1	Harmonic distortion standards	1
2.2	power system quantities under non-sinusoidal conditions	1
2.3	harmonic indices-source of harmonics-system response characteristics	1
2.4	Effect of power system harmonics on power system equipment and loads	1
2.5	principles for controlling harmonics, reducing harmonic currents in loads, filtering	1
2.6	modifying the system frequency response	1
2.7	Devices for controlling harmonic distortion	1
2.8	inline reactors or chokes, zigzag transformers	1
2.9	Passive filters, active filters.	1
3	ELECTROMAGNETIC INTERFERENCE	
3.1	Introduction to EMI & Frequency Classification	2
3.3	Electrical Fields - Magnetic Fields	1
3.4	EMI Terminology & Power Frequency Fields	2
3.5	High Frequency Interference	1
3.6	EMI Susceptibility & EMI Mitigation & Health Concerns of EMI	3
4	POWER QUALITY CONDITIONERS	
4.1	Shunt and series compensators	1
4.2	Distribution STATCOMS (DSTATCOMS) and Dynamic Voltage Restorers (DVRs)	1
4.3	Rectifier supported DVR, DC Capacitor supported DVR,	1
4.4	DVR Structure , Voltage Restoration	1
4.5	Series Active Filter & Unified power quality conditioners	2
4.7	Sensors and measurement techniques	1
5	POWER QUALITY MONITORING	
5.1	Monitoring consideration - power quality measurement equipment	1
5.2	assessment of power quality measurement data	1
5.3	application of intelligent system & power quality monitoring standards	1
5.5	Power quality monitoring and analysis	1
5.6	Case study for 220/110 kV substation	1
5.7	DSP-based solutions for electric power industry	1
5.8	Power Quality Monitoring and Analysis of the Domestic Grids	1
5.9	Analysis of voltage dips in power system.	1
	Total	45

Course Designers

1. Mr. N. Rajasekaran - rajasekaran.n@ksrct.ac.in

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


 BoS Chairman Signature

60 PPS E22	Solar and Energy Storage Systems	Category	L	T	P	Credit
		PE	3	0	0	3

Objective

- To explain basics of solar photovoltaic systems and energy storage system
- To understand the concepts protection and reliability of stand-alone PV system
- To gain the knowledge about grid connected central PV system.
- To know the design of interconnected PV systems as central power stations
- To provide the knowledge about the various applications of solar power and energy storage system

Prerequisite

NIL

Course Outcomes

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

CO1	Describe the basics of solar system	Remember
CO2	Recognize the concepts of standalone PV system	Understand
CO3	Design the grid connected system for various applications	Create
CO4	Select the suitable energy storage system for solar energy	Analyze
CO5	Recognize the various applications of solar system	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	3	
CO2	3	3	2	2		
CO3	3	3	2	3	3	2
CO4	3	3	2	3	2	
CO5	3	3	2	2	3	2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		End Sem Examination(Marks)
	1	2	
Remember	30	10	30
Understand	20	10	10
Apply	10	10	30
Analyse	0	20	20
Evaluate	0	0	0
Create	0	10	10

K.S.Rangasamy College of Technology – Autonomous R 2022								
60 PPS E22 - Solar and Energy Storage Systems								
M.E. Power Systems Engineering								
Professional Elective - II								
Semester	Hours / Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	100
Introduction to Solar Energy Characteristics of sunlight: the sun and its radiation, Solar radiation, Direct and diffusion radiation, greenhouse effect, solar isolation data and estimation-semiconductors and P-N junctions: semiconductors and types, absorption of light, recombination and PN junctions –behavior of solar cells – cell properties: efficiency and losses, Top contact design, Laser grooved, Buried contact solar cell – Laser grooved, Buried contact solar cell, Environmental and thermal protection.								10
Stand-alone PV System Solar Modules – Power conditioning and regulation: Diodes, Regulators, Inverters- Balance of system components - protection – stand-alone PV systems design – sizing: Reliability maps, sizing for high reliability, existing methods. storage systems: Types, applications, requirements, efficiency, Lead acid batteries.								10
Grid Connected PV Systems Building integrated PV systems, Grid connected PV systems, Hybrid systems, – Utility applications for photo voltaic – design issues for central power stations – safety – Economic aspect – Efficiency and performance – Integration of PV and Wind – Indian Specific Standard for grid Integration.								10
Energy Storage Systems Impact of intermittent generation: Battery energy storage – solar thermal energy storage – pumped hydroelectric energy storage.								10
Applications of solar energy Water pumping – battery chargers – solar car – direct-drive applications –Space – Telecommunications.								05
Total Hours :45								
Text book(s):								
1.	Solar Energy – S.P. Sukhatme, Tata McGraw Hill, 2017.							
2.	Stuart R.Wenham, Martin A.Green, Muriel E. Watt and Richard Corkish, “Applied Photovoltaics”, 2011.							
Reference(s):								
1.	Frank S. Barnes & Jonah G. Levine, “Large Energy storage Systems Handbook”, CRC Press, 2017.							
2.	S. Sumathi, “Solar PV and Wind Energy Conversion Systems (Green Energy and Technology)”, L. Ashok Kumar , P. Surekha, 2015.							
3	https://nptel.ac.in/courses/112/105/112105051/							
4	https://nptel.ac.in/content/storage2/courses/10810309/download/M9.pdf							

Course Contents and Lecture Schedule

S.No	Topic	#Hrs
1	INTRODUCTION TO SOLAR ENERGY	
1.1	Characteristics of sunlight: The sun and its radiation, Solar radiation, Direct and diffusion radiation	2
1.2	Greenhouse effect, Solar isolation data and Estimation	2
1.3	Semiconductors and P-N junctions	1
1.4	Behavior of solar cells	1
1.5	Laser grooved, Buried contact solar cell	2
1.6	Laser grooved, Buried contact solar cell	1
1.7	Environmental and thermal protection.	1
2	STAND-ALONE PV SYSTEM	
2.1	Solar Modules – Power conditioning and regulation	1
2.2	Inverters- Balance of system components - protection –	1
2.3	stand-alone PV systems design – sizing	2
2.4	Reliability maps, existing methods sizing for high reliability,	2
2.5	Storage systems: Types,	1
2.6	Applications, requirements,	1
2.7	Lead acid batteries	1
2.8	Efficiency - Battery's	1
3	GRID CONNECTED PV SYSTEMS	
3.1	Introduction – point of common Connection	1
3.2	Building integrated PV systems, Integration of PV and Wind	2
3.3	Indian Specific Standard for grid Integration	2
3.4	Efficiency and performance, Grid connected PV systems Hybrid systems, Utility applications for photo voltaic	3
3.5	Design issues for central power stations safety, Economic aspect	2
4	ENERGY STORAGE SYSTEMS	
	Introduction	1
4.1	Impact of intermittent generation	2
4.2	Battery energy storage	2
4.3	Solar thermal energy storage	2
4.4	Pumped hydroelectric energy storage.	2
5	APPLICATIONS OF SOLAR ENERGY	
5.1	Water pumping	1
5.2	Battery chargers	1
5.3	Solar car	1
5.4	Direct-drive applications	1
5.5	Space – Application	1
	Telecommunications - Application	
	Total	45

Course Designers

Dr.Aravindan

- aravindan@ksrct.ac.in

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

60 PPS E23	PWM TECHNIQUES AND ITS APPLICATIONS	Category	L	T	P	Credit
		PE	3	0	0	3

Objective

- To understand the concept pulse width modulation and analysis of its waveform
- To analyses the different Programmed Modulation Strategies for PWM generation.
- To apply PWM in voltage source inverter topology for controlled ac output.
- To understand the concept of harmonic losses and methods elimination methods.
- To apply the space vector modulation techniques for different topology and analyses its solution

Prerequisite

NIL

Course Outcomes

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

CO1	Explain the fundamental concepts of pulse width modulation techniques	Understand
CO2	List the types of pulse width modulation techniques based on its performance index	Analyze
CO3	Make use of inverter topologies in applying PWM	Understand
CO4	Explain the strategies involved for harmonic elimination using PWM	Analyze
CO5	Summarize the space vector modulation techniques and its advantages	Understand

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	2	2
CO2	3	3	3	2	2	2
CO3	3	3	3	2	2	2
CO4	3	3	3	2	2	2
CO5	3	3	3	2	2	2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		End Sem Examination (Marks)
	1	2	
Remember	20	30	30
Understand	30	30	60
Apply	10	0	10
Analyse	0	0	0
Evaluate	0	0	0
Create	0	0	0

K.S.Rangasamy College of Technology – Autonomous R2022								
60 PPS E23 – PWM TECHNIQUES AND ITS APPLICATIONS								
POWER SYSTEMS ENGINEERING								
Professional Elective - II								
Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	100
Fundamentals of PWM Fundamental Concepts of PWM - Evaluation of PWM Schemes - Double Fourier Integral Analysis of a Two-Level PWM waveform - Naturally Sampled PWM - PWM Analysis by Duty Cycle Variation - Regular Sampled PWM- Direct modulation.								[9]
Programmed Modulation Strategies: Integer versus non integer frequency ratios- Review of PWM variations – Optimized spaced vector PWM- Harmonic elimination PWM - Performance index for optimality - optimum PWM – Minimum loss PWM.								[9]
Modulation of VSI: Topology of a Single Phase Inverter -Three level Modulation of a Single Phase Inverter Analytic Calculation of Harmonic Losses-Sideband Modulation-Switched Pulse Position-Switched Pulse Sequence - Topology of a Three Phase VSI-Three Phase Modulation with Sinusoidal References								[9]
Harmonics and Control: Third Harmonic Reference Injection-Analytic Calculation of Harmonic Losses Discontinuous Modulation Strategies- Triplen Carrier Ratios and Sub harmonics- Multilevel converter alternatives - Harmonic Elimination applied to multilevel inverters- Minimum Harmonic distortion.								[9]
Space Vector Modulation: Phase Leg References - Naturally Sampled SVM-Analytical Solution for SVM Harmonic Losses for SVM- Placement of the Zero Space Vector-Discontinuous Modulation- SVM for multilevel inverters- discontinuous modulation in multilevel inverters								[9]
TotalHours								45
Text Book(s):								
1.	Mohammed H. Rashid, “Power Electronics-Circuits, Devices and Applications”, 3rd Edition, Eastern Economy Edition, 2004. 2. 3.							
2	Grahame D. Holmes and Thomas A. Lipo, “Pulse width Modulation for Power Converters”, IEEE Press series on Power Engineering, Wiley, 2003.							
Reference(s):								
1.	Dorin O. Neacsu, “Power Switching Converters: Medium and High Power”, CRC Press, Taylor & Francis, 2006							
2.	Isaak D Mayergoyz, SiddharthTyagi“Pulse Width Modulation In Power Electronics”,World Scientific, 2021.							
3.	Pulse width Modulation for Power Electronic Converters, IISc Bangalore, , Prof. G. Narayanan,NPTEL Course. https://freevideolectures.com/course/3345/pulse-width-modulation-for-power-electronic-converters							
4.	Marian K. Kazimierczuk, “Pulse-Width Modulated Dc-Dc coverters”, John Wiley and Sons Ltd, March 2014							

Rev.No. 02 / w.e.f. 12.06.2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

Course Contents and Lecture Schedule

S.No	Topic	No.of Hours
1	Fundamentals of PWM	
1.1	Fundamental Concepts of PWM	1
1.2	Evaluation of PWM Schemes	1
1.3	Double Fourier Integral Analysis of a Two-Level PWM waveform	2
1.4	Naturally Sampled PWM	2
1.5	PWM Analysis by Duty Cycle Variation -	1
1.6	Regular Sampled PWM-	1
1.7	Direct modulation.	1
2	Programmed Modulation Strategies:	
2.1	Integer versus non integer frequency ratios	1
2.2	Review of PWM variations	1
2.3	Optimized spaced vector PWM-	1
2.4	Harmonic elimination PWM	1
2.5	Performance index for optimality	1
2.6	optimum PWM	1
2.7	Minimum loss PWM.	1
3	Modulation of VSI:	
3.1	Topology of a Single Phase Inverter	1
3.2	Three level Modulation of a Inverter	
3.3	Single Phase Inverter Analytic Calculation of Harmonic Losses	2
3.4	Sideband Modulation	1
3.5	Switched Pulse Position	1
3.6	Switched Pulse Sequence	2
3.7	Topology of a Three Phase VSI-	1
3.8	Three Phase Modulation with Sinusoidal References	1
4	Harmonics and Control:	
4.1	Third Harmonic Reference Injection-	1
4.2	Analytic Calculation of Harmonic Losses Discontinuous	1
4.3	Modulation Strategies-	1
4.4	Triplen Carrier Ratios	1
4.5	Sub harmonics-	2
4.6	Multilevel converter alternatives	1
4.7	Harmonic Elimination	1
5	Space Vector Modulation:	
5.1	Phase Leg References -	1
5.	Naturally Sampled SVM-	1
5.3	Analytical Solution for SVM Harmonic Losses for SVM- -	1
5.4	Placement of the Zero Space Vector	1
5.5	-Discontinuous Modulation	1
5.6	SVM for multilevel inverters-	1
5.7	discontinuous modulation in multilevel inverters	1
	Total	45

Course Designers

Dr.D.SriVidhya

- srividhya@ksrct.ac.in

Rev.No. 02 / w.e.f. 12.06.2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


 BoS Chairman Signature

60 PPS E24	EHV AC Transmission	Category	L	T	P	Credit
		PE	3	0	0	3

Objectives

- To Calculate the Value of Line Inductance and Capacitance of EHV transmission Line
- To understand the concept of Voltage gradients of conductors.
- To develop the empirical formula to determine the Corona loss occurring in EHV AC transmission Line.
- To calculate the Electrostatic field and to understand its effects over humans, animal and plants.
- To understand the basic concept of EHVAC cable for transmission system

Prerequisite

Generation, Transmission and **Distribution**

Course Outcomes

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

CO1	Calculate Line inductance and capacitances of bundled conductors.	Apply
CO2	Compute voltage gradients of transmission line conductors.	Analyse
CO3	Understand the effects of corona like Audible noise and Radio Interference	Understand
CO4	Analyze the effects of electrostatic field on living and nonliving Organisms.	Analyze
CO5	Analyze the design and protection aspects of HHVAC cable Transmission.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	2	3	2
CO2	2	3	3	2	3	3
CO3	3	3	3	2	3	3
CO4	3	3	3	2	3	2
CO5	3	3	3	2	3	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		End Sem Examination(Marks)
	1	2	
Remember	10	10	10
Understand	10	10	30
Apply	20	20	30
Analyse	20	20	30
Evaluate	0	0	0
Create	0	0	0

K.S.Rangasamy College of Technology – Autonomous R2022									
60 PPS E24 – EHV AC Transmission									
M.E POWER SYSTEMS ENGINEERING									
Professional Elective - II									
Semester	Hours/Week			Total hrs	Credit	Maximum Marks			
	L	T	P		C	CA	ES	Total	
II	3	0	0	45	3	40	60	100	
CALCULATION OF LINE PARAMETERS									[9]
Role of EHV AC Transmission - Standard Transmission Voltages - Power-Handling Capacity and Line Loss - Costs of Transmission Lines and Equipment - Mechanical Considerations in Line Performance. Calculation of resistance, inductance and capacitance for multi-conductor lines – calculation of sequence inductances and capacitances – line parameters for different modes of propagation – Resistance and Inductance of Ground Return.									
VOLTAGE GRADIENTS OF CONDUCTORS									[9]
Electrostatics - Field of Sphere Gap - Field of Line Charges and Their Properties - Charge-Potential Relations for Multi-Conductor Lines - Surface Voltage Gradient on Conductors - Examples of Conductors and Maximum Gradients On Actual Lines - Examples of Conductors and Maximum Gradients On Actual Lines - Gradient Factors and Their Use - Distribution of Voltage Gradient on Sub-Conductors of Bundle - overhead line insulator, insulator performance in polluted environment. Monitoring of overhead transmission line - contactless technology									
CORONA EFFECTS									[9]
I ² R Loss and Corona Loss - Corona-Loss Formulae - Charge-Voltage (q–V) - Diagram and Corona Loss - Attenuation of Travelling Waves Due To Corona Loss - Audible Noise: Generation and Characteristics - Limits for Audible Noise - AN Measurement and Meters - Relation Between Single-Phase and 3-Phase AN Levels - Radio Interference: Corona Pulses: Their Generation and Properties - Properties of Pulse Trains and Filter Response - Limits for Radio Interference Fields - Measurement of Radio Interference- Television Interference (TVI)									
ELECTROSTATIC FIELD AND DESIGN OF EHV LINES									[9]
Electric Shock and Threshold Currents - Capacitance of Long Object -calculation of electrostatic field of AC lines- effect of high field on humans, animals, and plants - measurement of electrostatic fields - electrostatic Induction in unenergised circuit of a D/C line - induced voltages in insulated ground wires - electromagnetic interference, Design of EHV lines. EHVAC transmission lines maintenance techniques in Indian perspective — A review									
EXTRA HIGH VOLTAGE CABLE TRANSMISSION									[9]
Introduction - Electrical Characteristics of E.H.V. Cables - Properties of Cable-Insulation Materials - Breakdown and Withstand Electrical Stresses in Solid Insulation—Statistical Procedure - Design Basis of Cable Insulation - Tests on Cable Characteristics - Surge Performance of Cable Systems - Gas Insulated E.H.V. Lines									
Total Hours								45	
Text Book(s):									
1.	Rakosh Das Begamudre, “Extra High Voltage AC Transmission Engineering”, Second Edition, New Age International Pvt. Ltd., 2006.								
2.	PritindraChowdhari, “Electromagnetic transients in Power System”, John Wiley and Sons Inc., 2009.								
Reference(s):									
1.	Andrew R. Hileman, “Insulation Coordination for Power Systems”, CRC press, Taylor & Francis Group, New York, 1999.								
2.	Power Engineer's Handbook, Revised and Enlarged 6th Edition, TNEB Engineers' Association, October 2002.								
3.	Sunil S.Rao, “EHV-AC, HVDC Transmission & Distribution Engineering”, Third Edition, Khanna Publishers, 2008.								
4.	Gas Insulated Transmission Lines (GIL) – by Hermann Koch, Oct 2011, John Wiley & Sons.								

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023

BoS Chairman Signature



Course Contents and Lecture Schedule

S. No	Topic	#Hrs
1	CALCULATION OF LINE PARAMETERS	
1.1	Role of EHV AC Transmission - Standard Transmission Voltages	1
1.2	Power-Handling Capacity and Line Loss	1
1.3	Costs of Transmission Lines and Equipment	1
1.4	Mechanical Considerations in Line Performance	2
1.5	Calculation of resistance, inductance for multi-conductor lines	1
1.6	Calculation of capacitance for multi-conductor lines	1
1.7	calculation of sequence inductances – line parameters for different modes of propagation	1
1.8	calculation of sequence capacitances – line parameters for different modes of propagation	1
1.9	Resistance and Inductance of Ground Return.	1
2	VOLTAGE GRADIENTS OF CONDUCTORS	
2.1	Electrostatics - Field of Sphere Gap Field of Line Charges and Their Properties	1
2.2	Charge-Potential Relations for Multi-Conductor Lines	1
2.3	Surface Voltage Gradient on Conductors	1
2.4	Examples of Conductors and Maximum Gradients On Actual Lines	1
2.5	Examples of Conductors and Maximum Gradients On Actual Lines	1
2.6	Gradient Factors and Their Use	1
2.7	Distribution of Voltage Gradient on Sub-Conductors of Bundle	1
2.8	Overhead line insulator, insulator performance in polluted environment.	1
2.9	Monitoring of overhead transmission line - contactless technology	1
3	CORONA EFFECTS	
3.1	I ² R Loss and Corona Loss - Corona-Loss Formulae	1
3.2	Charge-Voltage (q-V) - Diagram and Corona Loss	1
3.3	Attenuation of Travelling Waves Due To Corona Loss	1
3.4	Audible Noise: Generation and Characteristics - Limits for Audible Noise	1
3.5	AN Measurement and Meters	1
3.6	Relation Between Single-Phase and 3-Phase AN Levels	1
3.7	Radio Interference: Corona Pulses: Their Generation and Properties	1
3.8	Properties of Pulse Trains and Filter Response - Limits for Radio Interference Fields	1
3.9	Measurement of Radio Interference- Television Interference	1
4	ELECTROSTATIC FIELD AND DESIGN OF EHV LINES	
4.1	Electric Shock and Threshold Currents	1
4.2	Capacitance of Long Object	1
4.3	calculation of electrostatic field of AC lines- effect of high field on humans, animals, and plants	1
4.4	measurement of electrostatic fields	1
4.5	electrostatic Induction in un-energised circuit of a D/C line	1
4.6	induced voltages in insulated ground wires	1
4.7	electromagnetic interference	1
4.8	Design of EHV lines	1
4.9	EHVAC transmission lines maintenance techniques in Indian perspective — A review	1
5	EXTRA HIGH VOLTAGE CABLE TRANSMISSION	
5.1	Introduction	1
5.2	Electrical Characteristics of E.H.V. Cables	1
5.3	Properties of Cable-Insulation Materials	1
5.4	Breakdown and Withstand Electrical Stresses in Solid Insulation	1
5.5	Statistical Procedure & Design Basis of Cable Insulation	2
5.6	Tests on Cable Characteristics & Surge Performance of Cable Systems	2
5.7	Gas Insulated E.H.V. Lines	1
Total		45

Course Designers

Mr.N.Rajasekaran

- rajasekaran.n@ksrct.ac.in

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


 BoS Chairman Signature

60 PPS E25	Machine Learning and Deep Learning	Category	L	T	P	Credit
		PE	3	0	0	3

Objective

- To Learn the concept of machine learning algorithms
- To familiarize the various architecture of networks
- To facilitate the pattern association using neural network
- To gain knowledge on pattern recognition and convolutional neural networks
- To gain knowledge on selection of neural network for specific applications

Prerequisite

NIL

Course Outcomes

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

CO1	Illustrate the categorization of machine learning algorithms	Understand
CO2	Compare and contrast the types of neural network architectures, activation functions.	Apply
CO3	Acquaint with the pattern association using neural networks.	Apply
CO4	Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks	Apply
CO5	Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Auto encoders, and GANs.	Analyze

Mapping with Programme Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	2	2	-	-	-	-	-	-	2
CO2	2	3	2	1	-	-	-	-	-	-	-	1
CO3	3	-	3	2	3	-	-	-	-	-	-	1
CO4	2	3	3	2	2	-	-	-	2	-	-	-
CO5	3	3	3	2	2	-	-	-	1	-	-	-
3- Strong;2-Medium;1-Some												

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		End Sem Examination (Marks)
	1	2	
Remember	20	20	20
Understand	60	20	20
Apply	20	20	30
Analyse	10	20	30
Evaluate	0	0	0
Create	0	0	0

K.S.Rangasamy College of Technology – Autonomous R2022								
60 PPS E25 – Machine Learning and Deep Learning								
Professional Elective - II								
Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	100
LEARNING PROBLEMS AND ALGORITHMS Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms								[9]
NEURAL NETWORKS Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning.								[9]
MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, over fitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering.								[9]
DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.								[9]
DEEP LEARNING: RNNs, AUTOENCODERS AND GANS State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Auto-encoders: Convolutional Auto-encoders, De-noising auto encoders, Variational auto encoders, GANs: The discriminator, generator, DCGANs.								[9]
Total Hours								45
Text Book(s):								
1.	J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning							
2	Deep Learning, Ian Good fellow, Yoshua Bengio and Aaron Courville, MIT Press, ISBN:9780262035613, 2016.							
Reference(s):								
1.	The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.							
2.	Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.							
3.	Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.							
4.	Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012.							

Course Contents and Lecture Schedule

S. No	Topic	N. H
1	LEARNING PROBLEMS AND ALGORITHMS	
1.1	Various paradigms of learning problems	3
1.2	Supervised Algorithm	2
1.3	Semi Supervised Algorithm	2
1.4	Unsupervised Algorithm	2
2	NEURAL NETWORKS	
2.1	Differences between Biological and Artificial Neural Networks	1
2.2	Typical Architecture - Common Activation Functions, Multi-layer neural network	1
2.3	Linear Separability	1
2.4	Hebb Net, Perceptron, Adaline	1
2.5	Standard Back propagation Training Algorithms for Pattern Association	1
2.6	Hebb rule and Delta rule	1
2.7	Hetero associative, Auto associative, Kohonen Self Organising Maps	1
2.8	Examples of Feature Maps, Learning Vector Quantization	1
2.9	Examples of Gradient Boltzmann Machine Learning.	1
3	MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS	
3.1	Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score	1
3.2	The curse of dimensionality	1
3.3	Training, Testing, Validation, Cross validation, Over fitting, under-fitting the data	1
3.4	Early stopping, regularization	1
3.5	Bias and variance & Feature Selection	2
3.7	Normalization, dimensionality reduction & Classifiers: KNN, SVM, Decision trees, Naïve Bayes	2
3.8	Binary classification, multi class classification, clustering	1
4	DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS	
4.1	Forward networks, Activation functions	1
4.2	Back propagation in CNN	1
4.3	Optimizers & Batch normalization	2
4.4	Convolution layers & Pooling layers	2
4.5	Fully connected layers & Dropout	2
4.6	Examples of CNNs	1
5	DEEP LEARNING: RNNs, AUTOENCODERS AND GANS	
5.1	State, Structure of RNN Cell	1
5.2	LSTM and GRU & Time distributed layers	2
5.3	Generating Text & Auto encoders: Convolutional Auto encoders	2
5.4	De-noising auto encoders & Variational auto encoders	2
5.5	GANs: The discriminator, generator	1
5.6	DCGANs	1
	Total	45

Course Designers

Dr.P.Premkumar

- premkumar@ksrct.ac.in

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2022

Approved in Academic Council Meeting held on 03/06/2023


 BoS Chairman Signature

60PPS E26	Electrical Power Distribution System	Category	L	T	P	Credit
		PE	3	0	0	3

Objective

- Describe the function of electric power distribution network
- Organize the voltage profile enhancement and protection schemes
- Appraise the reliability of the electrical distribution system
- Identify the automation schemes in various sections like substation, feeder, etc.,
- Implement the strategies for distribution system expansion.

Prerequisite

Generation, Transmission and Distribution

Course Outcomes

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

CO1	Explain fundamental knowledge in electric power distribution system.	Understand
CO2	Interpret the control and protection schemes for distribution systems.	Analyse
CO3	Discuss reliability of distribution systems.	Understand
CO4	Demonstrate the methodologies for distribution automation.	Apply
CO5	Examine strategies for expanding the existing distribution systems.	Analyse

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	3	3
CO2	3	2	3	3	3	3
CO3	3	2	3	3	3	3
CO4	3	2	3	3	3	3
CO5	3	2	3	3	3	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		End Sem Examination (Marks)
	1	2	
Remember	10	10	10
Understand	20	20	30
Apply	10	10	30
Analyze	20	20	30
Evaluate	0	0	0
Create	0	0	0

K.S.Rangasamy College of Technology – Autonomous R2022								
60 PPS E26 Electrical Power Distribution System								
M.E-Power Systems Engineering								
Professional Elective								
Semester	Hours / Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	100
DISTRIBUTION SYSTEMS Distribution systems: Types of distribution systems - Section and size of feeders – Primary and secondary distribution – Distribution substations – Effect of working voltage on the size of feeders and distributors – Effect of system voltage on economy – Voltage drop and efficiency of transmission - Qualitative treatment of rural distribution and industrial distribution.								[9]
CONTROL AND PROTECTION Voltage control: Application of shunt capacitance for loss reduction – Harmonics in the system – Static VAR systems – Voltage profile enhancement schemes. System protection: Fuses and section analyzers - Over current protection - Under voltage and under frequency protection – Coordination of protective device.								[9]
RELIABILITY ANALYSIS Primary and secondary system design considerations - Primary circuit configurations - Primary feeder loading - Secondary networks design- Economic design -Unbalance loads and voltage considerations.								[9]
DISTRIBUTION AUTOMATION Definitions – Automation switching control – Management information systems (MIS) – Remote terminal units – Communication methods for data transfer – Consumer information service (CIS) – Graphical information systems (GIS) - Automatic meter reading (AMR) – Remote control load management. Substation automation – Requirements – Control aspects in substations – Feeder automation – Consumer side automation.								[9]
EXPANSION PLANNING Distribution system planning: Short term planning - Long term planning - dynamic planning – Subtransmission and substation design. Sub-transmission networks configurations - Substation bus schemes - Distribution substations ratings - Service areas calculations. Distribution system expansion: Planning – Load characteristics – Load forecasting – Design concepts – Optimal location of substation – Design of radial lines – Solution technique.								[9]
								45
Text Book(s):								
1.	C.L. Wadhwa, “Electrical Power Systems”, New Age International Publishers, Sixth Edition, 2014.							
2.	A.S. Pabla, “Electrical Power Distribution Systems”, Tata McGraw Hill Books Company, Sixth Edition, 2011.							
Reference(s):								
1.	V. Kamaraju, “Electrical Power Distribution Systems”, Tata McGraw Hill Books Company, Sixth Edition, 2009.							
2.	Anthony J. Pansini, “Electrical Distribution Engineering”, CRC Press, 2005.							
3.	H Lee Willis, “Distributed Power Generation Planning and Evaluation”, CRC Press, 2000.							
4.	James A Momoh, “Electric Power Distribution Automation Protection and Control” CRC Press, 2007.							

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

Course Contents and Lecture Schedule

S.No	Topic	#Hrs
1	DISTRIBUTION SYSTEMS	
1.1	Introduction	2
1.2	Types of distribution systems	
1.3	Section and size of feeders	1
1.4	Distribution substations	1
1.5	Effect of working voltage on the size of feeders and distributors	1
1.6	Effect of system voltage on economy	1
1.7	Voltage drop and efficiency of transmission	1
1.8	Qualitative treatment of rural distribution and industrial distribution.	2
2	CONTROL AND PROTECTION	
2.1	Introduction	1
2.2	Voltage control: Application of shunt capacitance for loss reduction –	1
2.3	Harmonics in the system	1
2.4	Static VAR systems	1
2.5	Voltage profile enhancement schemes.	1
2.6	System protection: Fuses and section analyzers	1
2.7	Over current protection	1
2.8	Under voltage and under frequency protection	1
2.9	Coordination of protective device.	1
3	RELIABILITY ANALYSIS	
3.1	Introduction	1
3.2	Primary and secondary system design considerations	2
3.3	Primary circuit configurations	1
3.4	Primary feeder loading	1
3.5	Secondary networks design	1
3.6	Economic design	1
3.7	Unbalance loads and voltage considerations.	2
4	DISTRIBUTION AUTOMATION	
4.1	Introduction	1
4.2	Definitions-Automation switching control-Management information systems (MIS) - Remote terminal units	2
4.3	Communication methods for data transfer-Consumer information service (CIS)- Graphical information systems (GIS)-Automatic meter reading (AMR)	2
4.4	Remote control load management.	1
4.5	Substation automation-Requirements-Control aspects in substations	2
4.6	Feeder automation-Consumer side automation	1
5	EXPANSION PLANNING	
5.1	Introduction	2
5.2	Distribution system planning: -Short term planning-Long term planning-Dynamic planning	
5.3	Subtransmission and substation design.	1
5.4	Sub-transmission networks configurations	1
5.5	Substation bus schemes	1
5.6	Distribution substations ratings Service areas calculations.	1
5.9	Distribution system expansion: -Planning-Load characteristics	1
5.10	Load forecasting-Design concepts	1
5.11	Optimal location of substation-Design of radial lines-Solution technique	1
	Total	45

Course Designers

Mr.M.Dhanapal - ghanapalm@ksrct.ac.in

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

60 PAC 001	ENGLISH FOR RESEARCH PAPER WRITING	Category	L	T	P	Credit
		AC	2	0	0	0

Objective

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

Prerequisite

NIL

Course Outcomes

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

CO1	Understand that how to improve your writing skills and level of readability
CO2	Learn about what to write in each section
CO3	Understand the skills needed when writing a Title
CO4	Understand the skills needed when writing the Conclusion
CO5	Ensure the good quality of paper at very first-time submission

Assessment Pattern

Bloom's Category	Continuous Assessment Tests(Marks)	
	1	2
Remember	10	10
Understand	20	20
Apply	30	30
Analyse	0	0
Evaluate	0	0
Create	0	0

K.S.Rangasamy College of Technology – Autonomous R2022								
60 PAC 001 - English for Research Paper Writing								
Common to all Branches								
Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P			CA	ES	Total
I	2	0	0	30	0	100	-	100
Introduction to Research Paper Writing Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness								[6]
Presentation Skills Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction								[6]
Title Writing Skills 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, Methods, Results, Discussion, Conclusions, The Final Check								[6]
Result Writing Skills Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions								[6]
Verification Skills Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first time submission								[6]
Total Hours								30
Text Book(s):								
1.	Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011							
2	Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006							
Reference(s):								
1.	Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006							
2.	Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.							
3.	Phill Williams, Advanced Writing skills for students of English, Rumian Publishers, 2018							
4.	Sudhir S. Pandhye, English Grammar and Writing Skills, Notion Press, 2017.							

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

60 PAC 002	DISASTER MANAGEMENT	Category	L	T	P	Credit
		AC	2	0	0	0

Objective

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches Teach how to improve writing skills and level of readability

Prerequisite

NIL

Course Outcomes

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

CO1	Summarize basics of disaster
CO2	Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3	Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4	Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5	Develop the strengths and weaknesses of disaster management approaches

Assessment Pattern

Bloom's Category	Continuous Assessment Tests(Marks)	
	1	2
Remember	10	10
Understand	20	20
Apply	30	30
Analyse	0	0
Evaluate	0	0
Create	0	0

K.S.Rangasamy College of Technology – Autonomous R2022								
60 PAC 002 – Disaster Management								
Common to all Branches								
Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
I / II	2	0	0	30	0	100	-	100
Introduction Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.								[6]
Repercussions of Disasters and Hazards Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made Disasters: Difference, Nature, Types and Magnitude.								[6]
Disaster Prone Areas In India Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics								[6]
Disaster Preparedness and Management Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and other Agencies, Media Reports: Governmental and Community Preparedness								[6]
Risk Assessment Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.								[6]
Total Hours								30
Text Book(s):								
1.	Goel S. L., Disaster Administration and Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi, 2009.							
2	Nishitha Rai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies ""New Royal book Company, 2007.							
Reference(s):								
1.	Sahni, Pardeep et.al., " Disaster Mitigation Experiences and Reflections", Prentice Hall of India, 2001.							
2.	Subramanian R, "Disaster Management", Vikas publishing Housing Pvt. Ltd., 2018.							
3.	Chu-hua Kuei, Christian N Madu, Handbook of Disaster Management Risk Reduction & Management: Climate change and Natural Disaster, world scientific, 2017.							
4.	Janki Andharia, Disaster studies: Exploring Intersectional ties in Disaster Discourse, Springer, 2020.							

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

60 PAC 003	CONSTITUTION OF INDIA	Category	L	T	P	Credit
		AC	2	0	0	0

Objective

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional. Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Prerequisite

NIL

Course Outcomes

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

CO1	Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
CO2	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India
CO3	Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
CO4	Discuss the passage of the Hindu Code Bill of 1956.
CO5	Discuss the role and functioning of election commission of India.

Assessment Pattern

Bloom's Category	Continuous Assessment Tests(Marks)	
	1	2
Remember	10	10
Understand	20	20
Apply	30	30
Analyse	0	0
Evaluate	0	0
Create	0	0

K.S.Rangasamy College of Technology – Autonomous R2022								
60 PCA 003 – Constitution of India								
Common to all Branches								
Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
I / II	2	0	0	30	0	100	-	100
History of Making of The Indian Constitution History, Drafting Committee, (Composition & Working)								[3]
Philosophy of The Indian Constitution Preamble, Salient Features								[3]
Contours of Constitutional Rights and Duties Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.								[6]
Organs of Governance Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.								[6]
Local Administration District's Administration head: Role and Importance Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Panchayat raj: Introduction, PRI: Zila Panchayat. Elected officials and their roles, CEO Zila Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.								[6]
Election Commission Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.								[6]
Total Hours								30
Text Book(s):								
1.	The Constitution of India,1950 (Bare Act),Government Publication.							
2	Busi S N, Ambedkar B R, "Framing of Indian Constitution", 1st Edition, 2015.							
Reference(s):								
1.	Jain, M P, "Indian Constitution Law", 7th Edition, Lexis Nexis,2014							
2.	Basu, D D, "Introduction to the Constitution of India", Lexis Nexis, 2015.							
3.	Bhansali S R., "Textbook on The Constitution of India", Universal Publishers, 2015							
4.	Jain, M P., "Outlines of Indian Legal and Constitutional History", Lexis Nexis, 2014							

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

60PPS301	HVDC and FACTS	Category	L	T	P	Credit
		BS	3	0	0	3

Objective

This course aims to understand the fundamentals of FACTS Controllers, to know the importance of controllable parameters and types of FACTS controllers & their benefits, to study HVDC Transmission system and understand the control aspects of HVDC System

Prerequisite

Power Electronics, Power Systems

Course Outcomes

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

CO1	Recognize proper FACTS controller for the specific application based on system requirements	Knowledge
CO2	Analyze the control circuits of Shunt Controllers, Series controllers & Combined controllers	Analyze
CO3	Understand the concepts of Power flow controllers	Understand
CO4	Distinguish EHV AC and HVDC system and to describe various types of DC links	Analyze
CO5	Describe various methods for the control of HVDC systems and to perform power flow analysis in AC/DC systems	Understand

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	1	1	3
CO2	3	3	2	2	1	
CO3	3	2	3	2	1	2
CO4	3	2	2	2	1	
CO5	3	2	2	2	3	1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)			End Sem Examination (Marks)
	1	2	3	
Knowledge	10	10	20	20
Understand	20	30	30	30
Apply	10	10	10	30
Analyse	20	10	10	20

K.S.Rangasamy College of Technology – Autonomous R2022								
60PPS301 - HVDC and FACTS								
M.E. Power Systems Engineering								
Semester	Hours/Week			Totalhrs	Credit	MaximumMarks		
	L	T	P			CA	ES	Total
	3	0	0	45	3	50	50	100
Facts concepts: Reactive power control in electrical power transmission, principles of conventional reactive power compensators. Introduction to FACTS, flow of power in AC parallel paths, meshed systems, basic types of FACTS controllers, definitions of FACTS controllers, brief description of FACTS controllers.								[09]
Static shunt and series compensators: Shunt compensation – objectives of shunt compensation, methods of controllable VAR generation, static VAR compensators – SVC, STATCOM, SVC and STATCOM comparison. Series compensation – objectives of series compensation, thyristor switched series capacitors (TCSC), static series synchronous compensator (SSSC), power angle characteristics, and basic operating control schemes.								[09]
Combined compensators: Unified power flow controller (UPFC) – Introduction, operating principle, independent real and reactive power flow controller and control structure. Interline power flow controller (IPFC), Introduction to Active power filtering, Concepts relating to Reactive power compensation and harmonic current compensation using Active power filters.								[09]
HVDC transmission: HVDC Transmission system: Introduction, comparison of AC and DC systems, applications of DC transmission, types of DC links, Layout of HVDC Converter station and various equipment's. HVDC Converters, analysis of bridge converters with and without overlap, inverter operation, equivalent circuit representation of rectifier and inverter configurations								[09]
Control of HVDC system: Principles of control, desired features of control, converter control characteristics, power reversal, Ignition angle control, current and extinction angle control. Harmonics introduction, generation, ac filters and dc filters. Introduction to multiterminal DC systems and applications, comparison of series and parallel MTDC systems, Voltage Source Converter based HVDC systems								
TotalHours								45
TextBook(s):								
1.	Hingorani ,L.Gyugyi, 'Concepts and Technology of Flexible AC Transmission System', IEEE Press New York, 2000 ISBN –078033 4588.							
2	Padiyar, K.R., 'HVDC transmission systems', Wiley Eastern Ltd., 2010.							
Reference(s):								
1.	Song, Y.H. and Allan T. Johns, 'Flexible AC Transmission Systems (FACTS)', Institution of Electrical Engineers Press, London, 1999.							
2.	Mohan Mathur R. and Rajiv K.Varma , 'Thyristor – based FACTS controllers for Electrical							
3.	Transmission systems', IEEE press, Wiley Inter science , 2002.							
4.	Padiyar K.R., 'FACTS controllers for Transmission and Distribution systems' New Age International Publishers, 1st Edition, 2007							
5.	Jos Arrillaga, 'High voltage Direct Current Transmission' IET Power and Energy Series 29							

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

Course Contents and Lecture Schedule

S.No	Topic	No. of Hours	Mode of content Delivery
1	Facts concepts:		
1.1	Reactive power control in electrical power transmission	1	LWD
1.2	Principles of conventional reactive power compensators	1	FC
1.3	Introduction to FACTS	2	LWD
1.4	Flow of power in AC parallel paths, meshed systems	2	LWD
1.5	Basic types of FACTS controllers,	1	LWD
1.6	Definitions of FACTS controllers,	1	LWD
1.7	Brief description of FACTS controllers.	1	LWD
2	Static shunt and series compensators:		
2.1	Shunt compensation	1	FC
2.2	objectives of shunt compensation,	2	LWD
2.3	methods of controllable VAR generation, static VAR compensators	1	LWD
2.4	SVC, STATCOM, SVC and STATCOM comparison. Series compensation	1	LWD
2.5	objectives of series compensation, thyristor switched series capacitors (TCSC)	1	LWD
2.6	static series synchronous compensator (SSSC)	1	LWD
2.7	power angle characteristics, and basic operating control schemes.	2	LWD
3	Combined compensators:		
3.1	Unified power flow controller (UPFC)	1	LWD
3.2	Introduction, operating principle	1	LWD
3.3	Independent real and reactive power flow controller and control structure.	1	LWD
3.4	Interline power flow controller (IPFC)	2	LWD
3.5	Introduction to Active power filtering,	2	LWD
3.6	Concepts relating to Reactive power compensation	1	LWD
3.7	Harmonic current compensation using Active power filters.	1	LWD
4	HVDC transmission:		
4.1	HVDC Transmission system: Introduction	1	LWD
4.2	Comparison of AC and DC systems,	1	FC
4.3	Applications of DC transmission, types of DC links	2	LWD
4.4	Layout of HVDC Converter station and various equipment's. HVDC Converters	2	LWD
4.5	Analysis of bridge converters with and without overlap, inverter operation	1	LWD
5	Control of HVDC system:		LWD
5.1	Principles of control	1	LWD
5.2	desired features of control	1	LWD
5.3	converter control characteristics, power reversal, Ignition angle control, current and extinction angle control.	2	LWD
5.4	Harmonics introduction, generation, ac filters and dc filters	1	LWD
5.5	Introduction to multiterminal DC systems and applications,	2	LWD
5.6	Comparison of series and parallel MTDC systems,	1	LWD
	Total	45	

Course Designers : Mr. S. Shree Ram Senthil

- shreeramsenthil@ksrct.ac.in

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

60 PPS E31	Power System Reliability	Category	L	T	P	Credit
		PE	3	0	0	3

Objective

- To introduce the basic concepts of reliability engineering
- To understand hierarchical levels in power system reliability assessment
- To study the formation of system model
- To learn the importance of reliability indices in power system planning, expansion, operation and control
- To acquire reliability design knowledge in engineering systems

Prerequisite

NIL

Course Outcomes

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

CO1	Acquire design knowledge of system components in reliability point of view.	Remember, Understand, Apply and Analyze
CO2	Understand the importance of customer oriented and system oriented indices.	Remember, Understand and Apply
CO3	Familiarize with reliability evaluation methodologies	Remember, Understand, Apply and Analyze
CO4	Analyse the system performance with proper remedial strategies	Remember, Understand, Apply and Analyze
CO5	Enrich the capability of analysing reliability design alternatives in engineering systems	Remember, Understand, Apply and Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	2	2
CO2	3	2	3	3	2	2
CO3	3	2	3	3	2	2
CO4	3	2	3	3	2	2
CO5	3	2	3	3	2	2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		End Sem Examination (Marks)
	1	2	
Remember	10	10	20
Understand	10	10	20
Apply	20	20	40
Analyse	10	10	20
Evaluate	0	0	0
Create	0	0	0

Rev.No. 02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

K.S.Rangasamy College of Technology – Autonomous R2022								
60 PPS E31 – Power System Reliability								
M.E. Power System Engineering								
	Hours/Week				Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
III	3	0	0	45	3	40	60	100
Introduction Definition of Reliability and Failure - Bathtub Curve - Concepts of Probability- Evaluation Techniques: Markov Process, Recursive Technique - Security levels of system – Reliability cost – Adequacy indices – Functions of system security – Contingency analysis – Linear sensitivity factors- Hierarchical Levels in Power System Reliability Assessment.								[9]
Generating Capacity: Basic Probability Methods Generation system models –Capacity outage probability tables – Loss of load indices – Equivalent forced outage rate – Capacity expansion analysis – Scheduled outages – Evaluation methods on period basis– Loss of energy indices.								[9]
Generating Capacity: Frequency and Duration Method Introduction – Generation model with no derated states– System risk indices with individual and cumulative load model– Practical system studies.								[9]
Composite Generation and Transmission System Introduction – Radial configurations – Conditional probability approach – Network configurations – State selection – System and load point indices – Application to practical system – Data requirements for composite system reliability evaluation.								[9]
Distribution System Introduction – Evaluation techniques –Interruption indices: Customer oriented, Load and Energy oriented – Application to radial systems – Effects of lateral distributor protection, disconnects, protection failures and transferring loads – Probability distribution of reliability indices								[9]
Total Hours								45
Text Book(s):								
1.	Dr. K. Uma Rao, “Power system operation & control”, Wiley-India, First edition, 2013.							
2.	Ali Chowdhury, Don Koval, “Power Distribution System Reliability: Practical Methods and Applications”, Wiley-IEEE Press, 2009.							
Reference(s):								
1.	Cepin, Marko, “Assessment of Power System Reliability”, Springer, 2011.							
2.	Roy Billinton, R.N. Allan, “Reliability Evaluation of Power Systems”, Springer, 1996.							
3.	M.V.F. Pereira, N.J. Balu, “Composite generation/transmission reliability evaluation”, Proceedings of the IEEE, Vol. 80, No. 4, pp. 470-491, 1992.							
4.	Jimmie J.Cathey , “Electric Machines Analysis Design Applying Matlab”, Mc Graw Hill Companies New Delhi, 2001							

Course Contents and Lecture Schedule

S.No	Topic	# Of Hours	MOD
1	INTRODUCTION		
1.1	Definition of Reliability and Failure	1	LWD
1.2	Bathtub Curve - Concepts of Probability	1	LWD
1.3	Evaluation Techniques: Markov Process,	1	LWD
1.4	Recursive Technique	1	LWD
1.5	Security levels of system – Reliability cost	1	LWD
1.6	Adequacy indices – Functions of system security	1	LWD
1.7	Contingency analysis	1	LWD
1.8	Linear sensitivity factors	1	LWD
1.9	Hierarchical Levels in Power System Reliability Assessment.	1	LWD
2	Generating Capacity: Basic Probability Methods		
2.1	Generation system models	1	LWD
2.2	Capacity outage probability tables	1	LWD
2.3	Loss of load indices	1	TPS
2.4	Equivalent forced outage rate	1	LWD
2.5	Capacity expansion analysis	1	LWD
2.6	Scheduled outages	1	LWD
2.7	Evaluation methods on period basis	2	LWD
2.8	Loss of energy indices	1	LWD
3	Generating Capacity: Frequency and Duration Method		
3.1	Introduction – Generation model with no derated states	2	FC
3.2	System risk indices with individual	2	LWD
3.3	cumulative load model	2	LWD
3.4	Practical system studies.	3	CS
4	Composite Generation and Transmission System		
4.1	Introduction – Radial configurations	1	CS
4.2	Conditional probability approach	1	CS
4.3	Network configurations	1	
4.4	State selection	1	LWD
4.5	System and load point indices	1	LWD
4.6	Application to practical system	2	LWD
4.7	Data requirements for composite system reliability evaluation	2	LWD
5	Distribution System	2	LWD
5.1	Introduction – Evaluation techniques	1	LWD
5.2	–Interruption indices: Customer oriented	2	LWD
5.3	Load and Energy oriented	1	LWD
5.4	Application to radial systems	2	LWD
5.5	Effects of lateral distributor protection	1	LWD
5.6	disconnects, protection failures and transferring loads	1	LWD
5.7	Probability distribution of reliability indices	1	LWD
	Total	45	LWD

Course Designers Dr. Elango M K - elango@ksrct.ac.in

60 PPS E32	Electromagnetic Interference and Compatibility in System Design	Category	L	T	P	Credit
		PE	3	0	0	3

Objective

- To understand the fundamentals of electromagnetic compatibility problems
- To know about the importance of Grounding and shielding
- To impart knowledge on filters to control EMI and EMC
- Acquire broad knowledge of various EM radiation measurement techniques
- To expose the knowledge on testing techniques as per Indian and international standards in EMI measurement.

Prerequisite

NIL

Course Outcomes

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

CO1	Classify the types and sources of Electromagnetic Interference	Remember, Understand and apply
CO2	Illustrate shielding to prevent electromagnetic radiation for cable and grounding	Remember, Understand and Apply
CO3	Design and analyse different types of EMI filters and shielding	Understand, Apply and Analyze
CO4	Examine the effect of EMI in elements and circuits	Understand, Apply and Analysis
CO5	Breakdown the effects of electrostatic discharge and testing techniques	Understand, Apply and Analysis

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	1	2		3		2	
CO2	2	1	1		3		2	
CO3	2	1	3		3		2	
CO4	2	1	2		3		2	
CO5	2	1	2		3		2	

3- Strong; 2-Medium; 1-Some

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		End Sem Examination (Marks)
	1	2	
Remember	10	10	30
Understand	20	20	30
Apply	30	20	30
Analyse	0	10	10
Evaluate	0	0	0
Create	0	0	0

K.S.Rangasamy College of Technology – Autonomous R2022								
60 PPS E32 - Electromagnetic Interference and Compatibility in System Design								
M.E Power Systems Engineering								
	Hours/Week				Credit	MaximumMarks		
	L	T	P		C	CA	ES	Total
I	3	0	0	45	3	40	60	
INTRODUCTION Definitions of EMI/EMC –Sources of EMI- Inter systems and Intra system- Conducted and radiated interference- Characteristics – Designing for electromagnetic compatibility (EMC)- EMC regulation typical noise path- EMI predictions and modeling, Methods of eliminating interferences and noise mitigation								[9]
GROUNDING AND CABLING Cabling- types of cables, mechanism of EMI emission / coupling in cables –capacitive coupling, inductive coupling- shielding to prevent magnetic radiation- shield transfer impedance, Grounding – safety grounds – signal grounds- single point and multipoint ground systems –hybrid grounds- functional ground layout –grounding of cable shields- -guard shields- isolation, neutralizing transformers, shield grounding at high frequencies, digital grounding- Earth measurement Methods								[9]
BALANCING, FILTERING AND SHIELDING Power supply decoupling- decoupling filters-amplifier filtering –high frequency filtering- EMI filters characteristics of LPF, HPF, BPF, BEF and power line filter design –Choice of capacitors, inductors, transformers and resistors, EMC design components –shielding – near and far fields shielding effectiveness- absorption and reflection loss- magnetic materials as a shield, shield discontinuities, slots and holes, seams and joints, conductive gaskets-windows and coatings – grounding of shields								[9]
EMI IN ELEMENTS AND CIRCUITS Electromagnetic emissions, noise from relays and switches, non-linearities in circuits, passive inter modulation, transients in power supply lines, EMI from power electronic equipment, EMI as combination of radiation and conduction								[9]
ELECTROSTATIC DISCHARGE, STANDARDS AND TESTING TECHNIQUES Static Generation- human body model- static discharges- ESD versus EMC, ESD protection in equipment- standards – FCC requirements – EMI measurements – Open area test site measurements and precautions- Radiated and conducted interference measurements, Control requirements and testing methods.								[9]
Total Hours								45
TextBook(s):								
1.	V.P. Kodali, “Engineering EMC Principles, Measurements and Technologies”, IEEE Press, Second Edition, 2010.							
2.	Henry W.Ott, “ Noise Reduction Techniques in Electronic Systems, 2nd Edition, John Wiley & Sons, 1989.							
Reference(s):								
1.	Bernhard Keiser, “Principles of Electro-magnetic Compatibility”, Artech House, Inc. (685 canton street, Norwood, MA 020062 USA) 1987.							
2.	Bridges, J.E Milleta J. and Ricketts.L.W., “EMP Radiation and Protective techniques”, John Wiley and sons, USA 1976.							
3.	William Duff G., & Donald White R. J, “Series on Electromagnetic Interference and Compatibility”, Vol. 6. Weston David A., “Electromagnetic Compatibility, Principles and Applications”, 1991							
4.	Clayton Paul, “Introduction to Electromagnetic Compatibility”, Wiley Interscience, 2006.							

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

60 PPS E33	Industrial Power System Analysis And Design	Category	L	T	P	C
		PE	3	0	0	3

Objective

- To impart knowledge on Motor Starting Studies.
- To understand the need for power factor correction and analyse the various methods that are used
- To learn about the sources of harmonics, evaluate the harmonics present in the power system and mitigate them by filters.
- To analyse the sources that can cause the voltage flicker and find solutions to minimize the flicker.
- To impart knowledge on the ground grid analysis.

Prerequisite

Electrical Machines, Power electronics, Power system analysis.

Course Outcomes

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

CO1	Perform motor starting studies.	Analyze
CO2	model and carry out power factor correction studies.	Apply
CO3	Perform harmonic analysis and reduce the harmonics by using filters.	Analyze
CO4	Carry out the flicker analysis by proper modeling of the load and its minimization.	Analyze
CO5	Design the appropriate ground grid for electrical safety.	Analyze

Mapping with Program Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2
CO1	3	3	3	3	3	2	2
CO2	3	3	3	3	3	2	2
CO3	3	3	3	3	3	2	2
CO4	3	3	3	3	3	2	2
CO5	3	3	3	3	3	2	3

AssessmentPattern

Bloom's Category	Continuous Assessment Tests (Marks)		End Sem Examination (Marks)
	1	2	
Remember	10	10	10
Understand	10	10	20
Apply	20	20	30
Analyse	20	20	40
Evaluate	0	0	0
Create	0	0	0

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

K.S.Rangasamy College of Technology – Autonomous R2022								
60PPSE33 - Industrial Power System Analysis and Design								
PPS: M.E. Power Systems Engineering								
Semester	Hours / Week			Total hrs	Credit	Maximum Marks		
	L	T	P			CA	ES	Total
III	3	0	0	45	3	50	50	100
MOTOR STARTING STUDIES Introduction-Evaluation Criteria-Starting Methods-System Data-Voltage Drop Calculations-Calculation of Acceleration time - Motor Starting with Limited - Capacity Generators – Computer - Aided Analysis - Conclusions.								[9]
POWER FACTOR CORRECTION STUDIES Introduction-System Description and Modeling-Acceptance Criteria-Frequency Scan Analysis- Voltage Magnification Analysis-Sustained Overvoltage's-Switching Surge Analysis-Back-to-Back Switching-Summary								[9]
HARMONIC ANALYSIS Harmonic Sources-System Response to Harmonics-System Model for Computer-Aided Analysis- Acceptance Criteria-Harmonic Filters-Harmonic Evaluation-Case Study-Summary and Conclusions.								[9]
FLICKER ANALYSIS Sources of Flicker-Flicker Analysis-Flicker Criteria-Data for Flicker analysis- Case Study-Arc Furnace Load-Minimizing the Flicker Effects-Summary								[9]
GROUND GRID ANALYSIS Introduction-Acceptance Criteria-Ground Grid Calculations-Computer-Aided Analysis - Improving the Performance of the Grounding Grids-Conclusions								[9]
Total Hours								45
Text book(s):								
1.	J Duncan Glover, Mulukutla S Sarma Thomas Overbye, “ Power System Analysis and Design ”, Cengage India Private Limited; 6th edition (9 January 2019)							
2.	Ramasamy Natarajan, "Computer-Aided Power System Analysis," 1st Edition, CRC Press, 2002							
Reference(s):								
1.	Barry Simon, “ Harmonic Analysis: A Comprehensive Course in Analysis,American Mathematical Society (1 May 2016)							
2.	https://www.researchgate.net/publication/224611178							
3.	https://www.wiley.com/en-us/Power+System+Harmonic+Analysis-p-9780471975489							
4.	https://nptel.ac.in/courses/108107157							

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

Course Contents and Lecture Schedule

S.No	Topic	No. of Hours	MoD
1	MOTOR STARTING STUDIES		
1.1	Introduction	2	LwD
1.2	Evaluation Criteria		LwD
1.3	Starting Methods and System Data.	1	PPT
1.4	Voltage Drop Calculations	1	LwD
1.5	Calculation of Acceleration time	1	LwD
1.6	Motor Starting with Limited	1	LwD
1.7	Capacity Generators	1	LwD
1.8	Computer- Aided Analysis - Conclusions	2	LwD
2	POWER FACTOR CORRECTION STUDIES		
2.1	Introduction	1	LwD
2.2	System Description and Modeling	2	LwD
2.3	Acceptance Criteria	1	LwD
2.4	Frequency Scan Analysis	1	RP
2.5	Voltage Magnification Analysis	1	LwD
2.6	Sustained Overvoltage's	1	LwD
2.7	Switching Surge Analysis	1	LwD
2.8	Back-to-Back Switching, Summary and Conclusions	1	LwD
3	HARMONIC ANALYSIS		
3.1	Introduction	1	LwD
3.2	Harmonic Sources	1	LwD
3.3	System Response to Harmonics	1	LwD
3.4	System Model for Computer	1	LwD
3.5	Aided Analysis	1	LwD
3.6	Acceptance Criteria	1	FC
3.7	Harmonic Filters	1	LwD
3.8	Harmonic Evaluation	1	LwD
3.9	Case Study-Summary and Conclusions	1	
4	FLICKER ANALYSIS		
4.1	Introduction	1	LwD
4.2	Sources of Flicker	1	GD
4.3	Flicker Analysis	2	LwD
4.4	Flicker Criteria	2	LwD
4.5	Data for Flicker analysis	2	LwD
4.6	Case Study-Arc Furnace Load-Minimizing the Flicker Effects	1	
5	GROUND GRID ANALYSIS		
5.1	Introduction	2	LwD
5.2	Acceptance Criteria		PPT
5.3	Ground Grid Calculations	1	LwD
5.4	Computer-Aided Analysis	2	LwD
5.5	Improving the Performance of the Grounding Grids-Conclusions	2	LwD
5.6	Unused Transmission Capacity Method- Case Study	2	LwD
	Total	45	

Course Designer: Dr.T.Venkatesan - venkatesan@ksrct.ac.in

Rev.No.02 / w.e.f. 12/06/2023
 Passed in BoS Meeting held on 13/05/2023
 Approved in Academic Council Meeting held on 03/06/2023


 BoS Chairman Signature

60 PPS E34	Advanced Power System Dynamics	Category	L	T	P	Credit
		PE	3	0	0	3

Objective

- To impart knowledge on mathematical modeling of a synchronous machine in detail.
- To enable the students to develop the transfer function model for excitation and speed governing systems.
- To offer an opportunity to innovate newer procedures and better methods for effective design.
- To enable the students to model the single and multi-machine power systems with controllers for stability analysis
- To provide knowledge on enhancing small signal stability concepts in power system

Prerequisite

Power System Analysis

Course Outcomes

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

CO1	Analyze the mathematical modeling and inductance calculations in a synchronous machine.	Understand, Analyse
CO2	Develop the transfer function model for excitation, speed governing and turbine systems.	Understand, Remember
CO3	Analyze the small signal stability of SMIB power systems.	Understand, Remember Analyse
CO4	Analyze the small signal stability of SMIB and Multi-machine power systems with damping controllers.	Understand, Remember Analyse
CO5	Describe feedback controllers for small signal stability enhancement in power systems.	Understand, Remember Analyse

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	3		2		2		3	3
CO2	3		2	1	2		3	3
CO3	3	1	2		1	2	3	3
CO4	3		3	2	2	3	3	3
CO5	2	2	2	2		3	3	3

3- Strong; 2-Medium; 1-Some

Assessment Pattern

Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	15	20	20
Understand	20	15	20	20
Apply	60	40	60	40
Analyse	0	30	0	20
Evaluate	0	0	0	0
Create	0	0	0	0

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

K.S.Rangasamy College of Technology – Autonomous R2018								
60 PPS E34 –Advanced Power System Dynamics								
PPS:M.E.PowerSystemsEngineering								
Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
1	3	0	0	45	3	40	60	100
SYNCHRONOUS MACHINE MODELLING Physical description of a synchronous machine: armature and field structure - direct and quadrature axes- Mathematical Description: Basic equations of a synchronous machine: stator circuit equations, stator self, stator mutual and stator to rotor mutual inductances, dq0 Transformation: flux linkage and voltage equations for stator and rotor in dq0 coordinates, Physical interpretation of dq0 transformation, Per Unit Representations: power invariant form of Park's transformation; Equivalent Circuits for direct and quadrature axes, Steady-state Analysis: Voltage, current and flux-linkage phasor relationships, Computation of steady-state values.								9]
MODELLING OF EXCITATION AND SPEED GOVERNING SYSTEMS Elements of an Excitation System: Types of Excitation System; Control and protective functions; Modeling of Excitation system components: Modeling of IEEE type ST1A (1992) excitation model, Turbine and Governing System Modeling: Classical transfer function of a hydraulic turbine (no derivation), Special characteristics of a hydraulic turbine, Electrical analogue of a hydraulic turbine, Governor for Hydraulic Turbine: Requirement for a transient droop, Block diagram of governor with transient droop compensation, Modeling of Single reheat tandem compounded type Steam Turbine.								[9]
SMALL-SIGNAL STABILITY ANALYSIS WITHOUT CONTROLLERS Classification of Stability, Concepts of Stability of Dynamic Systems: State-space representation, Eigen properties of the state matrix: Eigen values and eigenvectors for stability, Participation factor, Single-Machine Infinite Bus (SMIB) Configuration: Classical Machine Model stability analysis with numerical example, Effects of Field Circuit Dynamics: Block diagram representation with K-constants; expression for K-constants (no derivation), effect of field flux variation on system stability.								[9]
SMALL-SIGNAL STABILITY ANALYSIS WITH CONTROLLERS Effects of Excitation System: Thyristor Excitation System with AVR, Block diagram representation with Exciter and AVR, Effect of AVR on Synchronizing and Damping torque components, Power System Stabilizer: Block diagram representation with AVR and PSS, System state matrix including PSS- Illustration of principle of PSS application with numerical example -Small Signal Stability of Multi machine systems: illustration of formation of system state matrix for a two-machine system with classical models for synchronous machines.								[9]
ENHANCEMENT OF SMALL SIGNAL STABILITY Power System Stabilizer – Stabilizer based on shaft speed signal (delta omega) – Delta P-Omega stabilizer-Frequency-based stabilizers – Digital Stabilizer – Excitation control design – Exciter gain – Phase lead compensation – Stabilizing signal washout and stabilizer gain – Stabilizer limits, Selection of PSS location.								[9]
Total Hours								45
Text book(s):								
1.	PrabhaKundur, “Power System Stability and Control”, Tata McGraw-Hill, 2014.							
2.	R.Ramanujam, “Power System Dynamics: Analysis and Simulation”, PHI learning Private Limited, Second print, New Delhi, 2013.							
Reference(s):								
3.	Machowski, Bialek, Bumby, “Power System Dynamics and Stability”, John Wiley and sons, 3rd edition, 2020.							
4.	P. S. Kundur, N. J. Balu, and M. G. Lauby, "Power system dynamics and stability," Power System Stability and Control, vol. 3, 2017.							
5.	Vijay Vittal, James D. McCalley, Paul, P.M Anderson and A.A Fouad, “Power System Control and Stability”, Iowa State University Press, Ames, Iowa, 3rd edition, 2019.							
6.	P. W. Sauer and M. A. Pai, “Power System Dynamics and Stability”, Stipes Publishing Co, 2017.							

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

Course Contents and Lecture Schedule

S.No	Topic	#Hrs
1	SYNCHRONOUS MACHINE MODELLING	
1.1	Physical description of a synchronous machine: armature and field structure - direct and quadrature axes	2
1.2	Mathematical Description: Basic equations of a synchronous machine: stator circuit equations, stator self, stator mutual and stator to rotor mutual inductances	1
1.3	dq0 Transformation: flux linkage and voltage equations for stator and rotor in dq0 coordinates	1
1.4	Physical interpretation of dq0 transformation	1
1.5	Per Unit Representations: power invariant form of Park's transformation	1
1.6	Equivalent Circuits for direct and quadrature axes	1
1.7	Steady-state Analysis: Voltage, current and flux-linkage phasor relationships	1
1.8	Computation of steady-state values	1
2	MODELLING OF EXCITATION AND SPEED GOVERNING SYSTEMS	
2.1	Elements of an Excitation System: Types of Excitation System	1
2.2	Control and protective functions; Modeling of Excitation system components	1
2.3	Modeling of IEEE type ST1A (1992) excitation model	1
2.4	Turbine and Governing System Modeling: Classical transfer function of a hydraulic turbine (no derivation)	2
2.5	Special characteristics of a hydraulic turbine, Electrical analogue of a hydraulic turbine	1
2.6	Governor for Hydraulic Turbine: Requirement for a transient droop,	1
2.7	Block diagram of governor with transient droop compensation	1
2.8	Modeling of Single reheat tandem compounded type Steam Turbine	1
3	SMALL-SIGNAL STABILITY ANALYSIS WITHOUT CONTROLLERS	
3.1	Classification of Stability	1
3.2	Concepts of Stability of Dynamic Systems: State-space representation	2
3.3	Eigen properties of the state matrix: Eigen values and eigenvectors for stability	1
3.4	Participation factor, Single-Machine Infinite Bus (SMIB) Configuration: Classical Machine Model stability analysis with numerical example	2
3.5	Effects of Field Circuit Dynamics: Block diagram representation with K-constants	1
3.6	Expression for K-constants (no derivation)	1
3.7	Effect of field flux variation on system stability.	2
4	SMALL-SIGNAL STABILITY ANALYSIS WITH CONTROLLERS	
4.1	Effects of Excitation System: Thyristor Excitation System with AVR	1
4.2	Block diagram representation with Exciter and AVR	2
4.3	Effect of AVR on Synchronizing and Damping torque components	1
4.4	Power System Stabilizer: Block diagram representation with AVR and PSS, System state matrix including PSS	2
4.5	Illustration of principle of PSS application with numerical example	1
4.6	Small Signal Stability of Multi machine systems: illustration of formation of system state matrix for a two-machine system with classical models for synchronous machines.	2
5	ENHANCEMENT OF SMALL SIGNAL STABILITY	
5.1	Power System Stabilizer	1
5.2	Stabilizer based on shaft speed signal ($\Delta\omega$)	2
5.3	Delta P-Omega stabilizer-Frequency-based stabilizers	2
5.4	Digital Stabilizer – Excitation control design	1
5.5	Exciter gain – Phase lead compensation	1
5.6	Stabilizing signal washout and stabilizer gain	1
5.7	Stabilizer limits, Selection of PSS location	1
	Total	45

Course Designers

- Ms.N.Kayalvizhil - kayalvizhi@ksrct.ac.in

Rev.No.02 / w.e.f. 12/06/2023
 Passed in BoS Meeting held on 13/05/2023
 Approved in Academic Council Meeting held on 03/06/2023


 BoS Chairman Signature

60 PPS E35	PYTHON PROGRAMMING FOR MACHINE LEARNING	Category	L	T	P	Credit
		PE	3	0	0	3

Objective

- To use the basic programming principles such as data types, variable, conditionals, loops, recursion and function calls.
- To use basic data structures such as List, Dictionary and be able to manipulate text files and images.
- To make the students familiar with machine learning concepts & techniques.
- To understand the process and will acquire skills necessary to effectively attempt a machine learning problem and implement it using Python.
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired

Prerequisite

- Python Programming.

Course Outcomes

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

CO1	Develop skill in system administration and network programming by learning Python.	Understand, Remember & Apply
CO2	Demonstrating understanding in concepts of Machine Learning and its implementation using Python	Understand, Remember & Apply
CO3	Relate to use Python's highly powerful processing capabilities for primitives, modelling etc	Understand, Remember & Apply
CO4	Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design.	Understand, Remember & Apply
CO5	Apply the concepts acquired over the advanced research/employability skills	Understand, Remember & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	-	-	2	3	3		1	1
CO2	3	1	3	-	3		1	1
CO3	2	1	2	-	3		1	1
CO4	3	2	3	3	3		1	1
CO5	-	-	-		3		1	1

3- Strong; 2-Medium; 1-Some

Assessment Pattern

Category	Continuous Assessment Tests			End Sem Examination
	1	2	3	
Remember	20	15	20	20
Understand	20	15	20	20
Apply	60	40	60	40
Analyse	0	30	0	20
Evaluate	0	0	0	0
Create	0	0	0	0

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

K.S.Rangasamy College of Technology – Autonomous R2022								
60 PPS E35 – PYTHON PROGRAMMING FOR MACHINE LEARNING								
PPS:M.E.Power Systems Engineering								
Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P			C	CA	ES
1	3	0	0	45	3	40	60	100
INTRODUCTION TO MACHINE LEARNING AND PYTHON								
Introduction to Machine Learning: Significance, Advantage and Applications – Categories of Machine Learning – Basic Steps in Machine Learning: Raw Data Collection, Pre-processing, Training a Model, Evaluation of Model, Performance Improvement Introduction to Python and its significance – Difference between C, C++ and Python Languages; Compiler and Interpreters – Python3 Installation & Running – Basics of Python Programming Syntax: Variable Types, Basic Operators, Reading Input from User – Arrays/List, Dictionary and Set – Conditional Statements – Control Flow and loop control statements								[9]
PYTHON FUNCTIONS AND PACKAGES								
File Handling: Reading and Writing Data – Errors and Exceptions Handling – Functions & Modules – Package Handling in Python – Pip Installation & Exploring Functions in python package – Installing the Numpy Library and exploring various operations on Arrays: Indexing, Slicing, Multi-Dimensional Arrays, Joining Numpy Arrays, Array intersection and Difference, Saving and Loading Numpy Arrays – Introduction to SciPy Package & its functions - Introduction to Object Oriented Programming with Python								[9]
IMPLEMENTATION OF MACHINE LEARNING USING PYTHON								
Description of Standard Datasets: Coco, ImageNet, MNIST (Handwritten Digits) Dataset, Boston Housing Dataset – Introducing the concepts of Regression – Linear, Polynomial & Logistic Regression with analytical understanding - Introduction to SciPy Package & its functions – Python Application of Linear Regression and Polynomial Regression using SciPy – Interpolation, Overfitting and Underfitting concepts & examples using SciPy								[9]
CLASSIFICATION AND CLUSTERING CONCEPTS OF ML								
Introduction to ML Concepts of Clustering and Classification – Types of Classification Algorithms – Support Vector Machines (SVM) - Decision Tree - Random Forest – Introduction to ML using scikitlearn – Using scikit-learn, Loading a sample dataset, Learning & prediction, interpolation & fitting, Multiclass fitting - Implementation of SVM using Blood Cancer Dataset, Decision Tree using data from csv. Types of Clustering Algorithms & Techniques – K-means Algorithm, Mean Shift Algorithm & Hierarchical Clustering Algorithm – Introduction to Python Visualization using Matplotlib: Plotting 2- dimensional, 3-dimensional graphs; formatting axis values; plotting multiple rows of data in same graph – Implementation of K-means Algorithm and Mean Shift Algorithm using Python								[9]
INTRODUCTION TO NEURAL NETWORKS AND EMBEDDED MACHINE LEARNING								
Introduction to Neural Networks & Significance – Neural Network Architecture – Single Layer Perceptron & Multi-Layer Perceptron (MLP) – Commonly Used Activation Functions - Forward Propagation, Back Propagation, and Epochs – Gradient Descent – Introduction to Tensorflow and Keras ML Python packages – Implementation of MLP Neural Network on Iris Dataset – Introduction to Convolution Neural Networks – Implementation of Digit Classification using MNIST Dataset ML for Embedded Systems: Comparison with conventional ML – Challenges & Methods for Overcoming – TinyML and Tensorflow Lite for Microcontrollers – on-Board AI – ML Edge Devices: Arduino Nano BLE Sense, Google Edge TPU and Intel Movidius								[9]
Total Hours								45
Text book(s):								
1.	Mark Lutz, "Learning Python, Powerful OOPs, O'reilly, 2011							
2.	Zelle, John "M. Python Programming: An Introduction to Computer Science.", Franklin Beedle &							

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

	Associates, 2003
Reference(s):	
1.	Andreas C. Müller, Sarah Guido, "Introduction to Machine Learning with Python", O'Reilly, 2016
2.	Sebastian Raschka, Vahid Mirjalili, "Python Machine Learning - Third Edition", Packt, December 2019
3.	Manaranjan Pradhan, U Dinesh Kumar, "Machine Learning using Python, Wiley Publisher January 2019.
4.	Andreas C. Müller, Sarah Guido Introduction to Machine Learning with Python O'Reilly Media Publisher(s) September 2016 ISBN: 9781449369897.

Content delivery and Schedule

S.No	Topic	Content delivery	No.ofHrs
1	INTRODUCTION TO MACHINE LEARNING AND PYTHON Introduction to Machine Learning: Significance, Advantage and Applications –	LWD	1
2	Categories of Machine Learning	LWD	1
3	Basic Steps in Machine Learning: Raw Data Collection, Pre-processing, Training a Model, Evaluation of Model,	LWD	1
4	Performance Improvement Introduction to Python and its significance	LWD	1
5	Difference between C, C++ and Python Languages;	LWD	1
6	Compiler and Interpreters – Python3 Installation & Running –	DEMO	1
7	Basics of Python Programming Syntax: Variable Types, Basic Operators	FC	1
8	Reading Input from User – Arrays/List, Dictionary and Set –	LWD	1
9	Conditional Statements – Control Flow and loop control statements	LWD	1
10	PYTHON FUNCTIONS AND PACKAGES File Handling: Reading and Writing Data	LWD	1
11	Errors and Exceptions Handling –	LWD	1
12	Functions & Modules – Package Handling in Python –	LWD	1
13	Pip Installation & Exploring Functions in python package –	LWD	1
14	Installing the Numpy Library and exploring various operations on Arrays:	LWD	1
15	Indexing, Slicing, Multi-Dimensional Arrays, Joining Numpy Arrays, Array	LWD	1
16	Difference, Saving and Loading Numpy Arrays	LWD	1
17	Introduction to SciPy Package & its functions -	FC	1
18	Introduction to Object Oriented Programming with Python	DEMO	1
19	IMPLEMENTATION OF MACHINE LEARNING USING PYTHON Description of Standard Datasets: Coco, ImageNet,	LWD	1
20	MNIST (Handwritten Digits) Dataset,	LWD	1
21	Boston Housing Dataset —	LWD	1
22	Introducing the concepts of Regression	LWD	1
23	Linear, Polynomial Regression	LWD	1
24	Logistic Regression with analytical understanding	LWD	1
25	Introduction to SciPy Package & its functions –	FC	1
26	Python Application of Linear Regression and Polynomial Regression using SciPy –	LWD	1

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

27	Interpolation, Overfitting and Underfitting concepts & examples using SciPy	LWD	1
28	CLASSIFICATION AND CLUSTERING CONCEPTS OF ML Introduction to ML Concepts of Clustering and Classification – Types of Classification Algorithms – Support Vector Machines (SVM)	LWD	1
29	Decision Tree - Random Forest – Introduction to ML using scikitlearn – Using scikit-	LWD	1
30	Loading a sample dataset, Learning & prediction, interpolation & fitting, Multiclass fitting	LWD	1
31	- Implementation of SVM using Blood Cancer Dataset, Decision Tree using data	LWD	1
32	Types of Clustering Algorithms & Techniques – K-means Algorithm,	LWD	1
33	Mean Shift Algorithm & Hierarchical Clustering Algorithm –	LWD	1
34	Introduction to Python Visualization using Matplotlib: Plotting 2- dimensional,	FC	1
35	3-dimensional graphs; formatting axis values; plotting multiple rows of data in same	LWD	1
36	Implementation of K-means Algorithm and Mean Shift Algorithm using Python	LWD	1
37	INTRODUCTION TO NEURAL NETWORKS AND EMBEDDED MACHINE LEARNING Introduction to Neural Networks & Significance – Neural Network Architecture – Single Layer Perceptron	LWD	1
38	Multi-Layer Perceptron (MLP) – Commonly Used Activation Functions	LWD	1
39	Forward Propagation, Back Propagation, and Epochs – Gradient Descent	LWD	1
40	Introduction to Tensorflow and Keras ML Python packages –	DEMO	1
41	Implementation of MLP Neural Network on Iris Dataset –	LWD	1
42	Introduction to Convolution Neural Networks –	FC	1
43	Implementation of Digit Classification using MNIST Dataset ML for Embedded	LWD	1
44	Comparison with conventional ML – Challenges & Methods for Overcoming –	LWD	1
45	Board AI – ML Edge Devices: Arduino Nano BLE Sense, Google Edge TPU and	LWD	1

Course Designers: Dr.D.Sri Vidhya – srividhya@ksrct.ac.in

Rev.No.02 / w.e.f. 12/06/2023
Passed in BoS Meeting held on 13/05/2023
Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

60 PPS E36	RENEWABLE ENERGY AND GRID INTEGRATION	Category	L	T	P	Credit
		PE	3	0	0	3

Objective

- To provide knowledge about the stand alone and grid connected renewable energy systems.
- To equip with required skills to derive the criteria for the design of power converters for renewable energy applications.
- To analyse and comprehend the various operating modes of wind electrical generators and solarenergy systems.
- To design different power converters namely AC to DC, DC to DC and AC to AC converters forrenewable energy systems.
- To develop maximum power point tracking algorithms.

Prerequisite

Nil

Course Outcomes

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

CO1	Relate the power generation of different renewable energy sources to grid impact and grid codes	Understand
CO2	Explain the design principles of solar energy management systems	Remember
CO3	Understand the power conversion system of wind generators	Apply
CO4	Analyze the different Maximum Power Point tracking Techniques	Analyse
CO5	Build grid connected and standalone renewable energy management system	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	3	2	2	2	2	2	2	2
CO2	3	2	2	2	2	2	2	2
CO3	3	2	2	2	2	2	2	2
CO4	3	2	2	2	2	2	2	2
CO5	3	2	2	2	2	2	2	2

3- Strong; 2-Medium; 1-Some

Assessment Pattern

Category	Continuous Assessment Tests			End Sem Examination
	1	2	3	
Remember	20	15	20	20
Understand	20	15	20	20
Apply	60	40	60	40
Analyse	0	30	0	20
Evaluate	0	0	0	0
Create	0	0	0	0

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

K.S.Rangasamy College of Technology – Autonomous R2018								
60 PPS E36 - RENEWABLE ENERGY AND GRID INTEGRATION								
PPS:M.E.Power Systems Engineering								
Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P			C	CA	ES
III	3	0	0	45	3	40	60	100
INTRODUCTION Introduction to renewable energy systems, environmental aspects of electric energy conversion,impacts of renewable energy penetration to grid. Grid Codes in India and other countries. Basicpower electronic converters for renewable energy integration to grid-Qualitative analysis -Boost andbuck-boost converters, three phase AC voltage controllers- AC-DC-AC converters, PWM Inverters,Grid Interactive Inverters-matrix converters.								[9]
PHOTO VOLTAIC ENERGY CONVERSION SYSTEMS Introduction, Photo Voltaic (PV) effect, Solar Cell, Types, Equivalent circuit of PV cell, PV cell characteristics (I/V and P/V) for variation of insolation, temperature and shading effect,Stand-alonePV system, Grid connected PV system, Design of PV system-load calculation, array sizing,selection of converter/inverter, battery sizing.								[9]
WIND ENERGY CONVERSION SYSTEMS Introduction, Power contained in wind, Efficiency limit in wind, types of wind turbines, Wind controlstrategies, Power curve and Operating area, Types of wind generators system based on Electricalmachines-Induction Generator and Permanent Magnet Synchronous Generator(PMSG), GridConnected-Single and Double output system, Self-excited operation of Induction Generator andVariable Speed PMSG.								[9]
MPPT TECHNIQUES IN SOLAR AND WIND SYSTEMS Case studies of PV-Maximum Power Point Tracking (MPPT) and Wind Energy system								[9]
HYBRID STORAGE SYSTEMS AND GRID MANAGEMENT Energy Storage systems, Need for Hybrid Systems, Features of Hybrid Systems, Range and typesof Hybrid systems (Wind-Diesel, PV-Diesel and Wind-PV)								[9]
Total Hours								45
Text book(s):								
1.	S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford University Press,2009.							
2.	Haitham Abu-Rub, Mariusz Malinowski and Kamal Al-Haddad, “Power Electronics forRenewable Energy Systems, Transportation and Industrial Applications”, IEEE Press and JohnWiley & Sons Ltd Press, 2014.							
Reference(s):								
1.	Rashid .M. H “power electronics Hand book”, Academic press, 2001.							
2.	Rai. G.D, “Non-conventional energy sources”, Khanna publishes, 1993							
3.	Gray, L. Johnson, “Wind energy system”, prentice hall linc, 1995							
4.	B.H.Khan, “Non-conventional Energy sources”, Tata McGraw-hill Publishing Company, NewDelhi.							

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

Course Contents and Lecture Schedule

S.No	Topic	# of Hrs	MoD
1	INTRODUCTION		
1.1	Introduction to renewable energy systems, environmental aspects of electric energy conversion	1	LWD
1.2	Impacts of renewable energy penetration to grid Grid Codes in India and other countries	2	LWD
1.3	Basic power electronic converters for renewable energy integration to grid-Qualitative analysis -Boost and buck-boost converters	2	LWD
1.4	Three phase AC voltage controllers- AC-DC-AC converters, PWM Inverters	2	LWD
1.5	Grid Interactive Converters-matrix converters	2	LWD
2	PHOTO VOLTAIC ENERGY CONVERSION SYSTEMS		
2.1	Photo Voltaic (PV) effect, Solar Cell	1	LWD
2.2	Types, Equivalent circuit of PV cell	1	LWD
2.3	PV cell characteristics (I/V and P/V) for variation of insolation, temperature and shading effect	1	TPS
2.4	Stand-alone PV system, Grid connected PV system	2	LWD
2.5	Design of PV system-load calculation, array sizing	2	LWD
2.6	selection of converter/inverter, battery sizing.	2	LWD
3	WIND ENERGY CONVERSION SYSTEMS		
3.1	Power contained in wind, Efficiency limit in wind	1	FC
3.2	types of wind turbines, Wind control strategies	1	LWD
3.3	Power curve and Operating area	1	LWD
3.4	Types of wind generators system based on Electrical machines-Induction Generator and Permanent Magnet Synchronous Generator(PMSG)	2	LWD
3.5	Grid Connected-Single and Double output system	2	LWD
3.6	Self-excited operation of Induction Generator and Variable Speed PMSG.	2	LWD
4	MPPT TECHNIQUES IN SOLAR AND WIND SYSTEMS		
4.1	Case studies of PV-Maximum Power Point Tracking (MPPT)	4	CS
4.2	Case studies of Wind Energy system	5	CS
5	HYBRID STORAGE SYSTEMS AND GRID MANAGEMENT		
5.1	Energy Storage systems	1	LWD
5.2	Need for Hybrid Systems	2	LWD
5.3	Features of Hybrid Systems	2	LWD
5.4	Range and types of Hybrid systems - Wind-Diesel,	1	LWD
5.5	PV-Diesel and Wind-PV	2	LWD
	Total	45	

Course Designers

1. R.Radhamani - radhamani@ksrct.ac.in



BoS Chairman Signature

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023

60 PPS E41	Computer Relaying and Wide Area Measurement Systems	Category	L	T	P	Credit
		PE	3	0	0	3

Objective

- To discriminate conventional relays and computer relays
- To comprehend the operating values of a computer relays
- To provide exposure to wide area measurement systems through the computer hierarchy in the substation, system relaying and control
- To inculcate knowledge on phasor measurement unit and its application to power system
- To enhance the conventional power system studies with wide area measurement techniques

Prerequisite

Advanced Power System Protection

Course Outcomes

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

CO1	Demonstrate knowledge of fundamental theories, principles and practice of computer relaying, Wide area measurement system.	Remember, Understand and Apply
CO2	Analyze the power system with computer relaying and Wide area measurement system.	Remember, Understand and Analyze
CO3	Validate the recent relaying technologies which work towards smart grid.	Remember, Understand and Analyze
CO4	Design wide area measurement systems for Smart grid.	Remember and Understand
CO5	Compare the performance of modern relaying schemes and measurement techniques with the conventional one.	Remember, Understand and Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3		3	-
CO2	3		3		3	3
CO3	3		3		-	3
CO4	3		3		-	3
CO5	3		3		3	3

Strong-3, Average-2, Some-1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		End Sem Examination (Marks)
	1	2	
Remember	10	10	10
Understand	20	20	30
Apply	10	10	30
Analyse	20	20	30
Evaluate	0	0	0
Create	0	0	0

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

K.S.Rangasamy College of Technology – Autonomous R2022								
60 PPS E41 - Computer Relaying and Wide Area Measurement Systems								
M.E – Power Systems Engineering								
Semester	Hours/Week			Totalhrs	Credit	MaximumMarks		
	L	T	P			CA	ES	Total
II	3	0	0	45	3	40	60	
Introduction Historical background - Expected benefits - Computer relay architecture - Analog to digital converters - Anti-aliasing filters - Substation computer hierarchy - Fourier series Exponential fourier series – Sine and cosine fourier series – Phasor.								[9]
Filters in Computer Relaying Walsh functions - Fourier transforms - Discrete fourier transform - Random processes - Filtering of random processes - Kalman filtering - Digital filters - Windows and windowing - Linear phase Approximation - Filter synthesis – Wavelets - Elements of artificial intelligence.								[9]
Computation of Phasors Introduction - Phasor representation of sinusoids - Fourier series and Fourier transform and DFT Phasor representation - Phasor Estimation of Nominal Frequency Signals - Formulas for updating phasors – Non-recursive updates - Recursive updates - Frequency Estimation.								[9]
Phasor Measurement Units A generic PMU - The global positioning system - Hierarchy for phasor measurement systems - Functional requirements of PMUs and PDCs - Transient Response of: Phasor Measurement Units, of instrument transformers, filters. Transient response during electromagnetic transients and power swings.								[9]
Phasor Measurement Applications State Estimation - History, Operator's load flow - Weighted least square: least square, Linear weighted least squares, Nonlinear weighted least squares - Static state estimation - State estimation with Phasors measurements - Linear state estimation – Protection system with phasor inputs: Differential and distance protection of transmission lines - Adaptive protection - Adaptive out-of-step protection.								[9]
TotalHours								45
Reference(s):								
1.	A.G. Phadke, J.S. Thorp, "Computer Relaying for Power Systems", John Wiley and Sons Ltd., Research Studies Press Limited, 2nd Edition, 2009.							
2.	A.G. Phadke, J.S. Thorp, "Synchronized Phasor Measurements and Their Applications", Springer, 2008.							
3.	Antonello Monti, Carlo Muscas, Ferdinando Ponci, "Phasor Measurement Units and Wide Area Monitoring Systems" Academic Press, 09-Jun-2016.							
4.	Stanley H. Horowitz, Arun G. Phadke, "Power System Relaying", John Wiley & Sons, 25-Oct-2013.							

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

Course Contents and Lecture Schedule

S.No	Topic	No.of Hours	Mode of content Delivery
1	Introduction		
1.1	Historical background	1	LwD
1.2	Expected benefits	1	LwD
1.3	Computer relay architecture	1	LwD
1.4	Analog to digital converters	1	FC
1.5	Anti-aliasing filters	1	LwD
1.6	Substation computer hierarchy	1	LwD
1.7	Fourier series Exponential fourier series	1	LwD
1.8	Sine and cosinefourier series	1	LwD
1.9	Phasor	1	LwD
2	Filters in Computer Relaying		
2.1	Walsh functions	1	LwD
2.2	Fourier transforms	1	LwD
2.3	Discrete fourier transform	1	LwD
2.4	Random processes	1	LwD
2.5	Filtering of randomprocesses		LwD
2.6	Kalman filtering	1	LwD
2.7	Windows and windowing		LwD
2.8	Linear phase Approximation	1	LwD
2.9	Filter synthesis	1	LwD
2.10	Wavelets	1	LwD
2.11	Elements of artificial intelligence	1	TPS
3	Computation of Phasors		
3.1	Introduction	1	LwD
3.2	Phasor representation of sinusoids	1	LwD
3.3	Fourier series and Fourier transform	1	LwD
3.4	DFT Phasor representation	1	Demo
3.5	Phasor Estimation of Nominal Frequency Signals	1	LwD
3.6	Formulas for updating phasors	1	LwD
3.7	Non-recursive updates	1	LwD
3.8	Recursive updates	1	LwD
3.9	Frequency Estimation	1	LwD
4	Phasor Measurement Units		
4.1	A generic PMU	1	LwD
4.2	The global positioning system	1	LwD
4.3	Hierarchy for phasor measurement systems	1	GD
4.4	Functional requirements of PMUs and PDCs	2	LwD
4.5	Transient Response of: Phasor Measurement Units Instrument transformers Filters	2	LwD
4.6	Transient response during Electromagnetic transients Power swings	2	LwD
5	Phasor Measurement Applications		

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


 BoS Chairman Signature

5.1	State Estimation History Operator's load flow	1	LwD
5.2	Weighted least square: Least square Linear weighted least squares Nonlinear weighted least squares	2	LwD
5.3	Static state estimation	1	LwD
5.4	State estimation with Phasors measurements	1	LwD
5.5	Linear state estimation	1	LwD
5.6	Protection system with phasor inputs: Differential and distance protection of transmission lines	1	FC
5.7	Adaptive protection	1	LwD
5.9	Adaptive out-of-step protection	1	LwD
	Total	45	

Course Designer

1. Mr.M.Dhanapal -ghanapalm@ksrct.ac.in

60 PPS E42	ENERGY MANAGEMENT IN POWER SYSTEMS	Category	L	T	P	C
		PE	3	0	0	3

Objective

- To study the energy scenario and Standards in energy
- To study the concepts behind economic analysis and load management
- To emphasize the energy management of various electrical equipment and metering
- To understand the basic concepts in Energy Auditing
- To illustrate the concept of energy management technologies

Prerequisite

Generation Transmission and Distribution, Power system analysis, power system operation and Control.

Course Outcomes

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

CO1	Understand the present energy scenario and role of energy managers.	Understand
CO2	Comprehend the Economic Models for cost and load management	Apply
CO3	Configure the Demand side energy management through its control techniques, strategy and planning	Analyze
CO4	Understand the process of energy auditing.	Apply
CO5	Implement energy conservation aspects in industries.	Understand

Mapping with Program Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	3	3	3	2	2	2
CO2	2	2	3	2	3	3	2	2
CO3	2	2	3	3	3	3	3	2
CO4	3	3	3	2	3	3	3	2
CO5	3	2	3	3	3	3	3	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		End Sem. Examination (Marks)
	1	2	
Remember	10	10	10
Understand	10	10	30
Apply	20	20	20
Analyse	20	20	40
Evaluate	0	0	0
Create	0	0	0

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

K.S.Rangasamy College of Technology – Autonomous R2022								
60 PPS E42 - ENERGY MANAGEMENT IN POWER SYSTEMS								
M.E. Power Systems Engineering								
Semester	Hours / Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
	3	0	0	45	3	50	50	100
ENERGY SCENARIO Basics of Energy and its various forms - Conventional and non-conventional sources - Energy policy - Energy conservation act 2001, Amendments (India) in 2010 - Definition and objectives of Energy Management - Need for energy management- Designing and starting an energy management program - Energy managers and energy auditors - Roles and responsibilities of energy managers - Energy labelling and energy standards – Introduction to ISO 50001: 2011 Energy Management system (EnMS).								[9]
ENERGY COST AND LOAD MANAGEMENT Important concepts in an economic analysis - Economic models -Time value of money-Utility rate structures- Cost of electricity-Loss evaluation- Load management : Demand control techniques-Utility monitoring and control system-HVAC and energy management-Economic justification.								[9]
ENERGY MANAGEMENT Demand side management (DSM) – DSM planning – DSM techniques – Load management as a DSMstrategy – Energy conservation via improving building envelop, Air-conditioning, Lighting: Electric motor and other industrial process and equipment: Load shifting and load leveling through Thermal Energy Storage– Tariff options for DSM.								[9]
ENERGY AUDITING Definition – Energy audit methodology: audit preparation, execution and reporting – Financial analysis– Sensitivity analysis – Project financing options - Instruments for energy audit – Energy audit for generation, distribution and utilization systems – Economic analysis.								[9]
ENERGY EFFICIENT TECHNOLOGIE Energy saving opportunities in electric motors - Power factor improvement benefit and techniques- Shunt capacitor, Synchronous Condenser and Phase Advancer - Energy conservation in industrial drives, electric furnaces, ovens and boilers - Lighting techniques: Natural, CFL, LED lighting sources and fittings.								[9]
Total Hours: 45								
Text book(s):								
1.	Barney L. Capehart, Wayne C. Turner, William J. Kennedy, “Guide to Energy Management”, CRC press, Taylor & Francis group, Eighth Edition, 2016.							
2.	Anil Kumar, Om Prakash ,Prashant Singh Chauhan “Energy Management: Conservation and Audits, CRC Press, 2020.							
Reference(s):								
1.	Eastop T.D and Croft D.R, “Energy Efficiency for Engineers and Technologists” , Logman Scientific & Technical, 1990.							
2.	S.C. Bhatia and SarveshDevraj, “Energy Conservation”, Woodhead Publishing India Pvt. Ltd, 2016.							
3.	IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 1996.							
4.	C.B. Smith , ‘Energy Management Principles’ Pergammon Press, 1981							

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

S.No.	Topic	No.of Hours	MoD
1	ENERGY SCENARIO		
1.1	Basics of Energy and its various forms	1	LWD
1.2	Conventional and non-conventional sources	1	PPT& Field
1.3	Energy policy : Energy conservation act 2001, Amendments	1	PPT
1.4	Definition and objectives of Energy Management	1	LWD
1.5	Need for energy management	1	LWD
1.6	Designing and starting an energy management program	1	PPT
1.7	Energy managers and energy auditors: Roles and responsibilities	1	LWD
1.8	Energy labelling and energy standards	1	PPT
1.9	Introduction to ISO 50001: 2011 Energy Management system (EnMS).	1	PPT
2	ENERGY COST AND LOAD MANAGEMENT		
2.1	Important concepts in an economic analysis	1	LWD
2.2	Economic models	1	LWD
2.3	Time value of money-Utility rate structures	1	LWD
2.4	Cost of electricity-Loss evaluation	1	LWD
2.5	Load management: Demand control techniques	1	PPT
2.6	Utility monitoring and control system	1	PPT
2.7	HVAC and energy management	1	PPT&FIELD
2.8	Economic justification.	1	LWD
2.9	Load shifting and load leveling through Thermal Energy Storage	1	PPT
3	ENERGY MANAGEMENT	1	
3.1	Demand side management (DSM)	1	TPS
3.2	DSM planning – DSM techniques	1	PPT
3.3	Load management as a DSM strategy	2	LWD
3.4	Energy conservation via improving building envelop	1	PPT
3.5	Air-conditioning, Lighting	1	PPT
3.6	Electric motor and other industrial process and equipment	1	LWD
3.7	Tariff options for DSM.	1	LWD
4	ENERGY AUDITING		
4.1	Definition – Energy audit methodology	1	PPT
4.2	audit preparation, execution and reporting	2	LWD & PPT
4.3	Financial analysis– Sensitivity analysis	1	LED
4.4	Project financing options	1	LWD
4.5	Instruments for energy audit	1	PPT
4.6	Energy audit for generation, distribution and utilization systems	2	Activity & LWD
4.7	Economic analysis.	1	LWD
5	ENERGY EFFICIENT TECHNOLOGIE		
5.1	Energy saving opportunities in electric motors	1	PPT
5.2	Power factor improvement benefit and techniques	2	PPT & FC
5.3	Shunt capacitor, Synchronous Condenser and Phase Advancer	2	PPT
5.4	Energy conservation in industrial drives electric furnaces, ovens and boilers	2	PPT & Field Visit
5.5	Lighting techniques: Natural, CFL, LED lighting sources and fittings.	2	LWD
	Total	45	

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

60 PPS E43	POWER SYSTEM INSTRUMENTATION	Category	L	T	P	Credit
		PE	3	0	0	3

Objective

- To use the processors in the process and their relative merits to be brought out.
- To explain the algorithms used in the investigation procedure and error analysis.
- To offer an opportunity to innovate newer procedures and better methods for effective design of instrumentation systems for power networks.
- To provide the knowledge on various controls and measurements involved in power plant
- To impart knowledge on distribution automation and substation controls

Prerequisite

NIL

Course Outcomes

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

CO1	Understand the basics of instrumentation and SCADA system implementation in Power System.	Remember, Understand and Apply
CO2	Understand and implement the controls involved in power plant instrumentation	Remember, Understand and Apply
CO3	Understand the functioning of distribution automation in power system network	Remember, Understand and Analyze
CO4	Understand concepts of substation automation and to implement the controls	Remember, Understand and Apply
CO5	Analyse the energy management techniques and energy audit	Remember, Understand and Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	2
CO2	3	2	3	3	2	2
CO3	3	3	3	2	2	2
CO4	3	2	3	3	2	3
CO5	3	2	3	3	3	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		End Sem Examination (Marks)
	1	2	
Remember	10	10	30
Understand	20	20	30
Apply	30	10	20
Analyse	0	20	20
Evaluate	0	0	0
Create	0	0	0

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

K.S.Rangasamy College of Technology – Autonomous R2022								
60 PPS E43 – POWER SYSTEM INSTRUMENTATION								
M.E.-POWER SYSTEMS ENGINEERING								
	Hours/Week				Credit	MaximumMarks		
	L	T	P		C	CA	ES	Total
I	3	0	0	45	3	40	60	100
MEASUREMENTSAND SCADASYSTEMS Measurement and error analysis. Object and philosophy o fpower system instrumentation to measurelarge currents, high voltages, Torque and Speed - Standard specifications – Data acquisition systems for Power System applications – DataTransmission and Telemetry – PLC equipment –computer control of power system-Man Machine Interface.								[9]
POWERPLANTINSTRUMENTATION Piping and Instrumentation diagram of thermal and nuclear power plants-Fuel measurement–gas analysis meters-smoke measurement-Monitoringsystems–measurement and control offurnace draft – measurement and control of combustion – Turbine monitoring and control: speed, vibration,shell temperature monitoring–radiation detection instruments–processsensors for nuclear power plants–spectrum nalyzers–nuclear reactor control systems and allied instrumentation.								[9]
DISTRIBUTIONAUTOMATION Definitions – automation switching control – management information systems (MIS) – remote terminalunits – communication method for data transfer – consumer information service (CIS) – graphical information systems(GIS)-automatic meter eading(AMR)–Remote control load management.								[9]
SUBSTATIONINSTRUMENTATION Sub-station automation – requirements – control aspects in substations – feeder automation – consumer side automation – reliability – GPIB program mable test instruments – microprocessor /microcontroller based GPIB controllers								[9]
ENERGY MANAGEMENTTECHNIQUESANDINSTRUMENTS Demand side management (DSM)– DSM planning – DSM Techniques – Load management as a DSM strategy–energy conservation–tariff options forDSM-Energy audit–instruments for energy audit–Energy audit for generation,distribution and utilizationsystems–economic analysis.								[9]
TotalHours								45
TextBook(s):								
1.	LiptakB.G,Instrumentation inProcessIndustries,Vol I andII,ChiltonBookCo.,1973.							
2.	SherryA..ModernPowerStationPractice.Vol.6(Instrumentation.controlsandTesting),Pergamon Press,1971.							
Reference(s):								
1.	Pabla.A.S“Electric powerdistribution“-TataMcGrawHill;NewDelhi 2004							
2.	MahalanaBisAK,KothariDPandAhsonSI“ComputeraidedPowerSystemanalysisandcontrol“-TataMcGraw Hill;New Delhi1988.							
3.	Murphy.W.RandMcKayG“EnergyManagement”ButterworthsPublications,London1982							
4.	Wayne CTuner “Energy ManagementHand Book”JohnWileyandSons,1982							

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

S.No	Topic	Content delivery	No.of Hrs
	MEASUREMENTS AND SCADA SYSTEMS		
1	Measurement and error analysis.	LWD	1
2	Object and philosophy of power system instrumentation to measure large currents, high voltages	LWD	1
3	Torque and Speed Standard specifications	LWD	1
4	Data acquisition systems for Power System applications	LWD	1
5	Data Transmission and Telemetry	PPT	1
6	PLC equipment	LWD	1
7	Computer control of power system	PPT	1
8	Man Machine Interface	SEMINAR	1
2	POWER PLANT INSTRUMENTATION		
1	Piping and Instrumentation diagram of thermal and nuclear power plants	LWD	1
2	Fuel measurement	LWD	1
3	Gas Analysis Meters-Smoke Measurement	PPT	2
4	Monitoring systems—measurement and control of furnace draft – measurement and control of combustion	LWD	1
5	Turbine monitoring and control: speed, vibration, shell temperature monitoring	LWD	2
6	Radiation Detection Instruments	SEMINAR	1
7	Process Sensors For Nuclear Power Plants	LWD	1
8	Spectrum analyzers—nuclear reactor control systems and allied instrumentation.	PPT	1
3	DISTRIBUTION AUTOMATION		
1	Definitions — communication method for data transfer	LWD	1
2	Management information systems (MIS)	PPT	2
3	Automation switching control — remote terminal units	LWD	2
4	Communication Method For Data Transfer	LWD	2
5	Consumer information service (CIS) – Graphical information systems (GIS)	PPT	1
6	Automatic meter reading (AMR)—Remote control load management	PPT	1
4	SUBSTATION INSTRUMENTATION		
1	Sub-station automation – requirements	LWD	1
2	Control aspects in substations – feeder automation	LWD	2
3	Consumer side automation – reliability	PPT	2
4	GPIO programmable test instruments	SEMINAR	2
5	Microprocessor /microcontroller based GPIO controllers	LWD	2
5	ENERGY MANAGEMENT TECHNIQUES AND INSTRUMENTS		
1	Demand side management (DSM)— DSM planning – DSM Techniques	LWD	1
2	Load management as a DSM strategy	LWD	2
3	Energy conservation—tariff options for DSM	PPT	2
4	Energy audit—instruments for energy audit	LWD	2
5	Energy audit for generation, distribution and utilization systems—economic analysis.	LWD	2
	Total		45

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


BoS Chairman Signature

60 PPS E44	Smart Grid	Category	L	T	P	Credit
		PE	3	0	0	3

Objective

- To impart knowledge on different Smart Grid technologies, different smart meters and advanced metering infrastructure
- To analyze and implement the technologies of smart grid in real time applications
- To solve engineering problems with the sound knowledge on power quality issues
- To use high performance computing techniques and communication protocols for smart grid

Prerequisite

Power system Analysis, Power System Operation and Control

Course Outcomes

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

CO1	Relate conventional grid with the smart grid and micro grid	Understand
CO2	Understand and apply the concepts of smart grid technology in industrial applications	Apply
CO3	Design and apply the smart metering concepts in real time applications	Apply
CO4	Experiment the issues of Power Quality in Smart Grid	Apply
CO5	Recommend suitable communication networks for smart grid applications and analyze performance of Smart Grid	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	3	2	2	2	2	2
CO2	3	3	3	2	3	3	3	3
CO3	3	3	3	2	3	3	3	3
CO4	3	3	3	2	3	3	3	3
CO5	3	3	3	2	3	3	3	3

3- Strong; 2-Medium; 1-Some

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		End Sem Examination (Marks)
	1	2	
Remember	10	10	10
Understand	20	20	30
Apply	30	30	40
Analyse	0	0	20
Evaluate	0	0	0
Create	0	0	0

Rev.No.02 / w.e.f. 12/06/2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023



BoS Chairman Signature

K.S.RangasamyCollegeofTechnology–AutonomousR2022								
60 PPS E44 - SMART GRID								
M.E., Power Systems Engineering								
Semester	Hours/Week			Total hrs	Credit	MaximumMarks		
	L	T	P		C	CA	ES	Total
	3	0	0	45	3	40	60	100
INTRODUCTION TO SMART GRID Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Comparison of Micro grid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study.								[9]
SMART GRID TECHNOLOGIES Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concept.								[12]
SMART METERS AND ADVANCED METERING INFRASTRUCTURE Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU) & their application for monitoring & protection, Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.								[9]
POWER QUALITY MANAGEMENT IN SMART GRID Power Quality & 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.								[6]
HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Neighbourhood Area Network (NAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.								[9]
TotalHours								45
TextBook(s):								
1.	Stuart Borlase ‘Smart Grid: Infrastructure, Technology and Solutions’, CRC Press 2012.							
2	JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, ‘Smart Grid: Technology and Applications’, Wiley, 2012.							
Reference(s):								
1.	Mini S. Thomas, John D McDonald, ‘Power System SCADA and Smart Grids’, CRC Press, 2015.							
2.	Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, ‘Communication Networks for Smart Grids’, Springer, 2014.							
3.	SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.							

Rev.No. 02 / w.e.f. 12.06.2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


 BoS Chairman Signature

Course Contents and Lecture Schedule

S.No	Topic	# of Hrs	MoD
1	INTRODUCTION TO SMART GRID		
1.1	Evolution of Electric Grid, Concept	1	PPT
1.2	Definitions and Need for Smart Grid	1	PPT
1.3	Smart grid drivers, functions	1	PPT
1.4	Opportunities, challenges and benefits of smart grid	1	PPT
1.5	Difference between conventional & Smart Grid	1	Self learning
1.6	Comparison of Micro grid and Smart grid	1	PPT
1.7	Present development & International policies in Smart Grid	1	PPT
1.8	Smart Grid Initiative for Power Distribution Utility in India, Case Study	2	PPT
2	SMART GRID TECHNOLOGIES		
2.1	Technology Drivers, Smart Integration of energy resources	1	BB
2.2	Smart substations, Substation Automation, Feeder Automation	2	PPT
2.3	Transmission systems: EMS, FACTS and HVDC	2	PPT
2.4	Wide area monitoring, Protection and control	2	PPT
2.5	Distribution Management system, Volt/Var control	1	PPT
2.6	Fault Detection, Isolation and service restoration	1	PPT
2.7	Outage management	1	PPT
2.8	High-Efficiency Distribution Transformers, Phase Shifting Transformers	1	Self Learning
2.9	Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concept	1	Self Learning
3	SMART METERS AND ADVANCED METERING INFRASTRUCTURE		
3.1	Introduction to Smart Meters	1	PPT
3.2	Advanced Metering infrastructure (AMI) drivers and benefits	2	PPT
3.3	AMI protocols, standards and initiatives, AMI needs in the smart grid	2	PPT
3.4	Phasor Measurement Unit(PMU) & their application for monitoring & protection,	2	Demo
3.5	Demand side management and demand response programs	1	PPT
3.6	Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing	1	PPT
4	POWER QUALITY MANAGEMENT IN SMART GRID		
4.1	Power Quality & EMC in Smart Grid	1	BB
4.2	Power Quality issues of Grid connected Renewable Energy Sources	1	Case study
4.3	Power Quality Conditioners for Smart Grid	1	PPT
4.4	Web based Power Quality monitoring	2	PPT
4.5	Power Quality Audit	1	BB
5	HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS		
5.1	Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Neighbourhood Area Network (NAN), Wide Area Network (WAN)	1	BB
5.2	Broadband over Power line (BPL)	1	BB
5.3	PLC, Zigbee, GSM	2	PPT
5.4	IP based Protocols	1	Case study
5.5	Basics of Web Service	1	PPT
5.6	Cloud Computing	2	PPT
5.7	Cyber Security for Smart Grid	1	PPT
	Total	45	

Course Designers

1. Dr.G.Vijayagowri -vijayagowri@ksrct.ac.in

Rev.No. 02 / w.e.f. 12.06.2023
 Passed in BoS Meeting held on 13/05/2023
 Approved in Academic Council Meeting held on 03/06/2023


 BoS Chairman Signature

60 PPS E45	Electric Vehicle and Power Management	Category	L	T	P	Credit
		PE	3	0	0	3

Objective

This course aims to know about the electrification of vehicle and impact of charging strategy.to develop the battery charger and to analyse the modelling of different batteries in Electric Vehicle to apply the concept of battery management and to gain knowledge about Power management

Prerequisite

NIL

Course Outcomes

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

CO1	Describe about the electrification of vehicle and impact of charging strategies.	Understand
CO2	Learn to develop a battery charger for an Electric Vehicle	Create
CO3	Analyze and modelling the different types of batteries used in EV	Analyze
CO4	Acquire Knowledge about Power management in hydraulically-controlled systems	Understand
CO5	Apply the concepts of battery management system and design the battery pack.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	1		1
CO2	2	3	1	2	2	3
CO3	1		2			3
CO4		1	1	1	3	1
CO5	1	1		2	3	
3- Strong;2-Medium;1-Some						

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		End Sem Examination (Marks)
	1	2	
Remember	10	10	10
Understand	20	20	30
Apply	30	30	40
Analyse	0	0	20
Evaluate	0	0	0
Create	0	0	0

K.S.Rangasamy College of Technology – Autonomous R2022								
60 PPS E45 - Electric Vehicles and Power Management								
M.E. Power Systems Engineering								
Semester	Hours/Week			Total hrs	Credit	MaximumMarks		
	L	T	P		C	CA	ES	Total
	3	0	0		45	3	50	50
MODULE I INTRODUCTION Introduction, Impact of charging strategies, EV charging options and infrastructure, energy, economic and environmental considerations, Impact of EV charging on power grid, effect of EV charging on generation and load profile, Smart charging technologies, Impact on investment								[09]
MODULE IIEV CHARGING Battery Chargers: Charge equalization, Conductive (Basic charger circuits, Microprocessor based charger circuit. Arrangement of an off-board conductive charger, Standard power levels of conductive chargers, Inductive (Principle of inductive charging, Soft-switching power converter for inductive charging), Battery indication methods								[12]
MODULE III BATTERY MODELLING Introduction,General approach to modelling batteries, simulation model of a rechargeable Li-ion battery, simulation model of a rechargeable NiCd battery, Parameterization of the NiCd battery model								[09]
MODULE IV: POWER FLOW AND POWER MANAGEMENT STRATEGIES IN HEV Mechanical power: generation, storage and transmission to the wheels Electric power: generation, storage and conversion to mechanical power. Hydraulic power: generation, storage and conversion to mechanical power, Energy storage/conversion and thermodynamic relations								
MODULE V– BATTERY PACK AND BATTERY MANAGEMENT SYSTEM Selection of battery for EVs & HEVs, Traction Battery Pack design, Requirement of Battery Monitoring, Battery State of Charge Estimation methods, Battery Cell equalization problem, thermal control, protection interface, SOC Estimation, Energy & Power estimation, Battery thermal management system, Battery Management System: Definition, Parts: Power Module, Battery, DC/DC Converter, load, communication channel, Battery Pack Safety, Battery Standards & Tests.								[09]
Total Hours								45
Text Book(s):								
1.	James Larminie Oxford Brookes University, Oxford, UK John Lowry Acenti Designs Ltd., UK, Electric Vehicle Technology Explained.							
2	Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.							
3	Guangjin Zhao, “Reuse and Recycling of Lithium-Ion Power Batteries”, John Wiley & Sons. 2017. (ISBN: 978-1-1193-2185-9).							
Reference(s):								
1.	Ibrahim Dinçer, Halil S. Hamut and Nader Javani, “Thermal Management of Electric Vehicle Battery Systems”, JohnWiley& Sons Ltd., 2016.							
2.	C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001.							
3.	Arno Kwade, Jan Diekmann, “Recycling of Lithium-Ion Batteries: The LithoRec Way”, Springer, 2018. (ISBN: 978-3-319-70571-2).							

Rev.No. 02 / w.e.f. 12.06.2023

Passed in BoS Meeting held on 13/05/2023

Approved in Academic Council Meeting held on 03/06/2023


 BoS Chairman Signature

Course Contents and Lecture Schedule

S.No	Topic	Hrs	MoD
1	INTRODUCTION		
1.1	Introduction	1	LWD
1.2	Impact of charging strategies	1	LWD
1.3	EV charging options and infrastructure	1	LWD
1.4	Energy economic and environmental considerations	1	LWD
1.5	Impact of EV charging on power grid	2	LWD
1.6	Effect of EV charging on generation and load profile	1	LWD
1.7	Smart charging technologies	1	LWD
1.8	Impact on investment	1	LWD
2	EV CHARGING		
2.1	Battery Chargers: Charge equalization	1	FC
2.2	Conductive -Basic charger circuits	1	LWD
2.3	Microprocessor based charger circuit	1	LWD
2.4	Arrangement of an off-board conductive charger	1	FC
2.5	Standard power levels of conductive chargers	2	LWD
2.6	Inductive principle of inductive charging	1	LWD
2.7	Soft-switching power converter for inductive charging	1	LWD
2.8	Battery indication methods	1	LWD
3	BATTERY MODELLING		
3.1	Introduction	1	LWD
3.2	General approach to Modelling batteries	2	LWD+Matlab
3.3	Simulation model of a rechargeable Li-ion battery	2	LWD+Matlab
3.4	Simulation model of a rechargeable Ni Cd battery	2	LWD+Matlab
3.5	Parameterization of the Ni Cd battery model	2	LWD+Matlab
4	POWER FLOW AND POWER MANAGEMENT STRATEGIES IN HEV		
4.1	Mechanical power: generation, storage and transmission to the wheels	2	LWD
4.3	Electric power: generation, storage and conversion to mechanical power	3	LWD+Matlab
4.4	Hydraulic power: generation, storage and conversion to mechanical power	2	LWD
4.5	Energy storage/conversion devices	1	LWD
4.6	Thermodynamic relations	1	LWD
5	BATTERY PACK AND BATTERY MANAGEMENT SYSTEM		LWD
5.1	Selection of battery for EVs & HEVs, Traction Battery Pack design	1	LWD
5.2	Requirement of Battery Monitoring, Battery State of Charge Estimation methods	1	LWD
5.3	Battery Cell equalization problem, thermal control, protection interface, SOC Estimation	2	LWD
5.4	Energy & Power estimation, Battery thermal management system	1	LWD
5.5	Battery Management System: Definition	1	LWD
5.6	Parts: Power Module, Battery, DC/DC Converter	1	LWD
	Total	45	

Course Designers

Mr. E. Chandra kumar - chandrakumar@ksrct.ac.in

Rev.No. 02 / w.e.f. 12.06.2023
 Passed in BoS Meeting held on 13/05/2023
 Approved in Academic Council Meeting held on 03/06/2023


 BoS Chairman Signature

60 PPS E46	DIGITAL CONTROLLERS IN POWER ELECTRONICS APPLICATIONS	Category	L	T	P	Credit
		ES	3	0	0	3

Objective

- To familiarize the basic concept on voltage source inverter.
- To facilitate the various types of digital current mode control.
- To provide exposure on the multi-sampled current controllers.
- To familiarize the control techniques of various types of inverters.
- To acquire knowledge on latest digital control paradigms.

Prerequisite

Control Systems, Power Electronics

Course Outcomes

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

CO1	Comprehend the basic concepts of voltage source inverter.	Understand
CO2	Model and analyze various digital current mode control.	Analyze
CO3	Understand the concept of multi-sampled current controllers.	Understand
CO4	Analyze the three phase inverters for various controllers.	Apply
CO5	Understand the new digital control paradigms using latest techniques	Understand

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	3	3	3	2	3	-	3	2
CO2	3	2	2	2	-	2	2	3
CO3	3	3	2	2	2	-	3	2
CO4	3	2	3	2	-	-	2	3
CO5	3	2	3	2	3	2	2	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		End Sem Examination (Marks)
	1	2	
Remember	10	10	30
Understand	20	20	30
Apply	30	10	30
Analyse	20	20	10
Evaluate	0	0	0
Create	0	0	0

K.S.Rangasamy College of Technology – Autonomous R2022								
60 PPS E46 - Digital Controllers in Power Electronics Applications								
M.E–Power Systems								
	Hours/Week				Credit	MaximumMarks		
	L	T	P		C	CA	ES	Total
I	3	0	0	45	3	40	60	100
Single-Phase Voltage Source Inverter- Test Bench: Voltage Source Inverter - Fundamental Components-Required Additional Electronics: Driving and Sensing– Principle of Operation- Low-Level Control of the Voltage Source Inverter: PWM Modulation- Digital PWM- Single Update and Double Update PWM Modes techniques- Analog Control Approaches.								[9]
Digital Current Mode Control: Requirements of the Digital Controller-Signal Conditioning and Sampling- Synchronization Between Sampling and PWM-Quantization Noise and Arithmetic Noise-Basic Digital Current Control Implementations - Proportional Integral Controller-Simplified Dynamic Model of Delays-Discretization Strategies.								[9]
Multi-Sampled Current Controllers: Oversampled PI Current Controller-Small-Signal Frequency Response Oversampled Predictive Current Controller-Digital, Fixed Frequency Hysteresis Current Controller-Large-Signal Response Test-FPGA Chip Utilization-Multi-Sampled Current Controllers.								[9]
Extension to Three-Phase Inverters&External Control Loops: The $\alpha\beta$ Transformation-Space Vector Modulation - Rotating Reference Frame Current Controller-Modeling the Internal Current Loop-Design of Voltage Controllers-Large Bandwidth Controllers-Narrow Bandwidth Controllers								[9]
New digital control paradigms: Flexibility and Performance-Distributed Generation Control Architectures -VSIs in Distributed Generation Grids - Control System Organization - Control Architecture-Controller Validation-Simulink Model - Real-Time, Hardware-in-the-Loop Simulation - Mitigation of Real-Time Simulation Artifacts.								[9]
TotalHours								45
TextBook(s):								
1.	Simone Buso and Paolo Mattavelli “Digital Control in Power Electronics”, 2nd EditionA Publication in the Springer series,2015							
2.	Simulations of machines using MATLAB and Simulink , John Francis Gardner, 2001							
Reference(s):								
1.	M. B. Patil, V. Ramanarayanan, V.T.Ranganathan, M.C.Chandorkar” Simulation of PowerConverters”,1st edition, Narosa Publishers,2010							
3.	J. Kassakian, M. F. Schlecht, and G. C. Verghese, Principles of Power Electronics, Addison-Wesley Publishing Company, 2001.							
4.	https://archive.nptel.ac.in/content/syllabus_pdf/10810518							
5.	Simulink Reference Manual, Math works, USA							

Course Contents and Lecture Schedule

S.No	Topic	# ofHrs	MoD
1	Single-Phase Voltage Source Inverter- Test Bench		
1.1	Voltage Source Inverter	1	LWD
1.2	Fundamental Components	1	LWD
1.3	Required Additional Electronics: Driving and Sensing	1	LWD
1.4	Low-Level Control of the Voltage Source Inverter	1	Flipped Class
1.5	PWM Modulation	1	LWD
1.6	Digital PWM	1	LWD
1.7	PWM Modes techniques	2	LWD
1.8	Analog Control Approaches	1	LWD
2	Digital Current Mode Control		
2.1	Requirements of the Digital Controller	1	LWD
2.2	Signal Conditioning and Sampling	1	LWD
2.3	Synchronization Between Sampling and PWM	1	LWD
2.4	Quantization Noise	1	Flipped Class
2.5	Arithmetic Noise	1	LWD
2.6	Basic Digital Current Control Implementations	1	LWD
2.7	Proportional Integral Controller	1	TPS
2.8	Simplified Dynamic Model of Delays	1	LWD
2.9	Discretization Strategies	1	LWD
3	Multi-Sampled Current Controllers		
3.1	Oversampled PI Current Controller	1	LWD
3.2	Small-Signal Frequency Response	1	LWD
3.3	Oversampled Predictive Current Controller	1	LWD
3.4	Digital Hysteresis Current Controller	1	Flipped Class
3.5	Fixed Frequency Hysteresis Current Controller	1	LWD
3.6	Large-Signal Response Test	1	LWD
3.7	FPGA Chip Utilization	2	LWD
3.8	Multi-Sampled Current Controllers	1	TQ
4	Extension to Three-Phase Inverters & External Control Loops		
4.1	The $\alpha\beta$ Transformation	1	LWD
4.2	Space Vector Modulation	1	LWD
4.3	Rotating Reference Frame Current Controller	1	Flipped Class
4.4	Modeling the Internal Current Loop	2	DEMO
4.5	Design of Voltage Controllers	2	DEMO
4.6	Large Bandwidth Controllers	1	LWD
4.7	Narrow Bandwidth Controllers	1	LWD
5	New digital control paradigms		
5.1	Flexibility and Performance	1	LWD
5.2	Distributed Generation Control Architectures	1	Flipped Class
5.3	VSI in Distributed Generation Grids	1	LWD
5.4	Control System Organization	1	LWD
5.5	Control Architecture & Validation	1	LWD
5.6	Simulink Model -Real-Time	1	DEMO
5.7	Hardware-in-the-Loop Simulation	2	DEMO
5.8	Mitigation of Real-Time Simulation Artifacts	1	LWD
	Total	45	

Course Designers: 1. Prabhu.Tprabhut@ksrct.ac.in

K.S.Rangasamy College of Technology – AutonomousR2022							
60 PPS 4P1 Project Work – Phase II							
PPS: M.E. Power Systems Engineering							
Semester	Hours/Week			Credit	Maximum Marks		
	L	T	P	C	CA	ES	Total
IV	0	0	24	12	50	50	100
Objective(s)	• To strengthens the students to carry out the project on their own. • To create an exposure to the students to refer, read and review the research articles. • To bring out research solutions for their identified problem. • To implement their innovative ideas to forefront the risk issues. • Toretrievethehazardsbyadoptingsuitablemethodologiesandbringingitintoglobal.						
Course Outcomes	At the end of the course, the students will be able to 1. Develop attitude of lifelong learning and will develop interpersonal skills to deal with people working in diversified field. 2. Collect and analyze the obtained data using software. 3. Write technical reports and research papers to publish at national and international level. 4. Develop strong communication skills to defend their work in front of technically qualified audience. 5. Demonstrate their responsibility as a member and a leader in a team.						
It is a continuation of Project work started in semester III. He has to submit the report in prescribed format and also present a seminar. The dissertation should be presented in standard format as provided by the department. The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion. The report must bring out the conclusions of the work and future scope for the study. The work has to be presented in front of the examiners panel consisting of an approved external examiner, an internal examiner and a guide, co-guide etc. As decided by the Head and PG coordinator. The candidate has to be in regular contact with his guide.							