OP JINDAL UNIVERSITY

Raigarh-Chhattisgarh

Scheme and Syllabus

of

PhD. Course work

Department of

Electrical Engineering

School of Engineering

OP JINDAL UNIVERSITY
OP Jindal Knowledge Park, Punjipathra, Raigarh - 496109, (C.G.)
t: +91 7762 304 000 www.opju.ac.in

Approved scheme of teaching, examination and syllabus for course work in PhD (Department of Electrical Engineering) by the members of the Board of Studies

Applicable from session 2022-2023

The scheme of teaching, examination and syllabus are hereby approved by the following members of the Board of Studies

V.C. Nominee (External Experts)	
Dr. K. B. Mohanty Professor, EE NIT-Rourkela, Orissa	**Dr. Madhu Singh** Professor, EE NIT Jamshedpur
Dr. Niranjan Kumar Assoc. Professor, EE NIT-Jamshedpur	**Dr. R. N. Patel** Assoc. Professor, EE NIT-Raipur.
Internal Experts:	
Dr. Mahesh Bhiwapurkar Professor, EE	**Dr. Deepak Singh** Associate Professor, EE
Dr. Sandeep Biswal Assistant Professor, EE	**Dr. Sushree Diptimayee Swain** Assistant Professor, EE
Dr. G. Madhusudhana Rao Head, EE, OPJU	

Syllabus of Course Work for Doctor of Philosophy (Ph.D.) in Electrical Engineering

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The PhD course work shall involve three papers and a seminar project. These three papers are:
1. Research Methodology,
2. Elective I
3. Elective II

Apart from these courses, there will be a seminar project.

Examination Scheme for Ph. D. Course Work in Electrical Engineering

Sl. No	Subject Code	Name of Subject	Credit	Examination Scheme				
				Theory		Seminars		TOTAL MARKS
				PRE	ESE	PRE	ESE	
1	**PCW 101**	Research Methodology	3	50	50	-----	----	100
2	**PCW 102**	Research and Publication Ethics	2	50	50	-----	-----	100
4	**SOE-P-EE 102**	Seminar Presentation	3	-----	-----	50	50	100
2	**SOE-P-EE 103 (1-4)**	Elective I	3	50	50	-----	----	100
3	**SOE-P-EE 104 (1-6)**	Elective II	3	50	50	-----	----	100
		TOTAL	**14**	**200**	**200**	**50**	**50**	**500**

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UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Electrical Engineering

Ph.D. (Electrical Engineering)

(DETAILED COURSEWORK SYLLABUS)

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SCHEME OF EXAMINATION:

The examination shall be conducted at the end of coursework. The Theory paper shall carry 100 Marks. The evaluation of the performance of the students in theory papers shall be based on the End Semester Examination of 100 Marks. Question Paper will be set in the view of the / following the entire syllabus and preferably covering each unit of syllabi in the unit pattern.

STANDARD OF PASSING:

As prescribed under Rules & Regulation for each degree/ programme

Sl No.	Subject code	Name of Subject
1	PCW 101	Research Methodology
2	PCW 102	Research and Publication Ethics
3	SOE-P-EE102	Seminar Presentation
	Elective – I	
4	SOE-P-EE103(1)	Power Electronics Applications in Renewable Energy.
5	SOE-P-EE103(2)	Soft Computing
6	SOE-P-EE103(3)	Computer Aided Power System Analysis
7	SOE-P-EE103(4)	Power System Optimization
	Elective – II	
8	SOE-P-EE104(1)	Advanced Power System Protection
9	SOE-P-EE104(2)	Power Electronic Devices & Circuits
10	SOE-P-EE104(3)	Power Electronics Controlled Electric Drives
11	SOE-P-EE104(4)	Solar Photovoltaic Technology
12	SOE-P-EE104(5)	Introduction To Python

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PROGRAM OUTCOMES FOR ENGINEERING DOCTORAL PROGRAM

1. **PO1-Engineering knowledge:** Apply the knowledge of mathematics in engineering for the analysis of complex problems.
2. **PO2-Problem analysis:** To find, formulate, and investigate complex problems and research-based knowledge, including innovative experiments in engineering disciplines to provide valid conclusions.

3. **PO3-Design and development of solutions:** Design solutions for complex engineering problems and develop the system components with appropriate techniques and resources consideration for society's benefit.

4. **PO4-Environment and sustainability:** Understand the impact of the professional engineering solutions and environmental contexts, validate the knowledge and need for sustainable development.

5. **PO5-Individual and teamwork:** Function effectively with contextual knowledge as an individual and member in diverse teams, professional ethics and responsibilities towards engineering practices.

6. **PO6-Execution of Project management:**
   To identify the funding agencies' knowledge in executing the proposal individually or collaborating with industrial/academic personalities at the national or international level.

PROGRAM-SPECIFIC OUTCOMES FOR ENGINEERING DOCTORAL PROGRAM

PSO	**Scholars will be able to:**
PSO1	Developing knowledge of the literature and a comprehensive understanding of scientific methods and techniques to teach problem-solving skills and critical thinking in Electrical Engineering.
PSO2	Provide scope for interaction with international researchers and developing Collaborations in multidisciplinary domains.

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Programme: **PhD**			
Name of the Course:	**Research Methodology**	**Course Code:**	**PCW 101**
Credits :	**3**	**No of Hours:**	**3 hrs/week**
Max Marks:	**100**		

Course Description:

The Research Methodology provides theoretical and practical knowledge and also the applied skills for research design and related methods and mixed-method research domains.

Course Objective:

1. How research papers are written;
2. How to read such papers critically and efficiently;
3. How to summarize and review them;
4. How to gain an understanding of a new field, in the absence of a textbook;
5. How to judge the value of different contributions;
6. How to identify promising new directions.

Syllabus:

UNIT - I

Meaning and significance of the research; Importance of scientific research in decision making; Types of research and research process; Identification of research problem and formulation of hypothesis.

UNIT - II

Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

UNIT - III

Qualitative and Quantitative Research, Measurement: Concept of measurement, Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal.

UNIT - IV

Factor analysis, Multiple Regressions Analysis. Discriminant Analysis, Use of SPS Package, IPR issues. Factor analysis, Multiple Regressions Analysis. Discriminant Analysis, Use of SPS Package, IPR issues.

UNIT - V

Research Report, Types and significance, Structure of research report, Ethical issues in research, Presentation of report. Interpretation of Data and Paper Writing, Journal selection, Impact factor of Journals. Plagiarism and Self-Plagiarism, Software for detection of Plagiarism.

Resources:

Name of Text and Reference Books:

1. Business Research Methods– Donald Cooper & Pamela Schindler, TMGH, 9th ed.
2. Business Research Methods– Alan Bryman & Emma Bell, Oxford University Press.
3. Research Methodology – C.R. Kothari.
4. Research Methodology, Chawla and Sondhi, Vikas Publication
5. Research Methodology, Paneersevam, PHI

Course Outcome:

CO	Doctoral candidates will be able to:
CO1	Identify a research topic in an appropriate scholarly manner.
CO2	Place a working hypothesis into a real context.
CO3	Use appropriate tools for data collection and analysis.
CO4	Match the research method to the research question.
CO5	Write up research projects using scholarly norms.
CO6	Communicate efficiently and consistently the outcomes of the research before an audience.
CO7	Critically review a research paper.
CO8	Manage deadlines in the crafting of a research paper.

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CO-PO & PSO Correlation:

Course Name: Research Methodology (PCW 101)								
	Program Outcomes						PSOs	
Course Outcomes	1	2	3	4	5	6	1	2
CO1:	1	2				1	1	
CO2:			1					1
CO3:		2				1		2
CO4:		3	1					
CO5:				1		1		
CO6:					1	1		
CO7:				1		1		
CO8:				1		1		

Note: 1: Low 2.: Moderate 3.: High

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Programme: **PhD**			
Name of the Course:	**Research and Publication Ethics**	**Course Code:**	**PCW 102**
Credits :	**2**	**No of Hours:**	**2 hrs/week**
Max Marks:	**100**		

Course Description:
This course has a total of 6 units focusing on the basics of the philosophy of science and ethics, research integrity and publication ethics. Sessions are designed to identify research misconduct and predatory publications. Indexing and citation databases, open-access publications, research metrics (citations, h-index, impact factor, etc.) and plagiarism tools are introduced in this course.

Course Objective:
At the end of this course, the learner is expected:

1. To understand the philosophy of science and ethics, research integrity and publication ethics.
2. To identify research misconduct and predatory publications.
3. To understand indexing and citation databases, open access publications, and research metrics (citations, h-index, Impact Factor, etc.).
4. To understand the usage of plagiarism tools.

Syllabus:

UNIT – I PHILOSOPHY & ETHICS (3 hrs.)
Introduction to philosophy: definition, nature and scope, concept, branches Ethics: definition, moral philosophy, nature of moral judgments and reactions.

UNIT – II SCIENTIFIC CONDUCT (5 hrs.)
Ethics with respect to science and research - Intellectual honesty and research integrity - Scientific misconducts: Falsification, Fabrication and Plagiarism (FFP) Redundant Publications: duplicate and overlapping publications, salami slicing - Selective reporting and misrepresentation of data.

UNIT – III PUBLICATION ETHICS (7 hrs.)

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Publication ethics: definition, introduction and importance - Best practices/standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest - Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types - Violation of publication ethics, authorship and contributor ship - Identification of publication misconduct, complaints and appeals - Predatory publisher and journals.

UNIT – IV OPEN ACCESS PUBLISHING (4 hrs.)

Open access publications and initiatives SHERPA/ROMEO online resource to check publisher copyright & self-archiving policies A software tool to identify predatory publications developed by SPPU - Journal finger/journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer, Journal Suggester, etc.

UNIT – V PUBLICATION MISCONDUCT (4 hrs.)

Group Discussion (2 Hrs.):
a) Subject-specific ethical issues, FFP, authorship
b) Conflicts of interest
c) Complaints and appeals: examples and fraud from India and abroad Software tools (2 Hrs.)
Use of plagiarism software like Turnitin, Urkund and other open source software tools.

UNIT – VI DATA BASE & RESEARCH METRICS (7 hrs.)

Databases (4 Hrs): Indexing databases, Citation databases: Web of Science, Scopus, etc. Research Metrics (3 Hrs.): Impact Factor of the journal as per Journal Citations Report, SNIP, SJR, IPP, Cite Score - Metrics: h-index, g index, i10 Index, altmetrics.

Note: Units 1, 2 and 3 are to be covered via Theory mode and Units 4, 5 and 6 are to be covered via practice mode

Resources:

Name of Text and Reference Books:

1. Nicholas H. Steneck. Introduction to the Responsible Conduct of Research. Office of Research Integrity, 2007.
   Available at: https://ori.hhs.gov/sites/default/files/rcrintro.pdf
2. Oliver P. The Student's Guide to Research Ethics, Open University Press, 2003
3. Shamoo Adil E and Resnik David B. Responsible Conduct of Research, Oxford University Press, 2003
4. Muralidhar Kambadur, Ghosh Amit and Singhvi Ashok Kumar Ethics in Science Education, Research and Governance Edited, Indian National Science Academy, 2019. ISBN: 978-81-939482-1-7.
5. Anderson B.H., Dursaton and Poole M.: Thesis and assignment writing, Wiley Eastern, 1997.

Course Outcome:

CO	Doctoral candidates will be able to:
CO1	Understand the ethics of the research
CO2	Undertsand the plagiarism and use appropriate tools
CO3	Know the various publication ethics as an author
CO4	Know the various publication methods and guidelines
CO5	Write up research projects using scholarly norms.
CO6	Understand the various unethical way and fraud in publication process

CO-PO & PSO Correlation:

Course Name: Research and Publication Ethics (PCW 102)								
	Program Outcomes						PSOs	
Course Outcomes	1	2	3	4	5	6	1	2
CO1:	1	2				1	1	
CO2:			1			1		1
CO3:		2						2
CO4:		1	1			1		
CO5:				1				2
CO6:					1	1		2

Note: 1: Low 2.: Moderate 3.: High

Programme: PhD			
Name of the Course:	**Seminar Presentation**	**Course Code:**	**SOE-P-EE102**
Credits :	**3**	**No of Hours:**	**5 hrs./week**
Max Marks:	**100**		

Course Description:

This subject has related to the techniques of scientific study and understanding of related research mobility and how to express in a scientific framework. The seminar has its importance in a career of a student to improve the logical communicative skills and confidence.

Objectives:

1. To set out the chosen research methods, including their theoretical basis, and the literature survey;
2. The experimental methods to be performed to reach a logical conceptual conclusion;
3. Aim to test the research methods opted and find the conceptual understanding.

Course Outcomes:

CO	**Doctoral candidates will be able to:**
CO1	Understand the research methods, interpretation approach and problem-solving skills.

CO-PO & PSO Correlation:

Course Name: Project report writing & Seminar (SOE-P-EE102)								
	Program Outcomes						**PSOs**	
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**
CO1:	**1**		**3**	**2**		**1**	**1**	**1**

Note: 1: Low 2.: Moderate 3.: High

The scholars will present seminar papers using these tools/concepts.

1. Review of Literature and its Analysis 25 Marks;

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2. Research Methodology with reference to the concerned subject, 25 Marks;
3. Report writing 25 marks;
4. References and citation 25 marks.

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Programme: **PhD**			
Name of the Course:	**Power Electronics Applications in Renewable Energy**	**Course Code:**	**SOE-P-EE103(1)**
Credits :	**3**	**No of Hours:**	**5 hrs./week**
Max Marks:	**100**		

Course Description:

The course aims to give the students basic knowledge of the design and operation of power electronic converters. It shall provide the students with a broad understanding of the vital role of power electronics in introducing renewable energy into the power system and how it may enhance energy saving.

Course Objective:

Develop an understanding of Power Electronics and switching mode power converters for renewable applications.

Syllabus

Unit 1: Introduction:

Environmental aspects of electric energy conversion: Features of Renewable Generation impacts of renewable energy generation, Qualitative study of different renewable energy resources: ocean, Biomass, Hydrogen energy systems, Solar PV, Fuel cells, wind electrical systems-control strategy, operating area, operating principles, and characteristics.

Unit 2: Solar Energy:

Introduction to Solar Energy: Solar radiation, availability, measurement and estimation, Solar thermal conversion devices and storage, solar cells, solar cell interconnection, solar cell characteristics, and photovoltaic conversion, analysis of PV systems, MPPT,Applications of PV System, solar energy collectors and storages-power electronics in solar Energy Utilization, DC-DC converters for solar PV systems.

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Unit 3: Wind Energy:

Wind Energy-Introduction, Basic principles of wind energy conversion system, Nature of wind site selection consideration, basic components of wind energy conversion system, Types of wind machines, basic components of wind electric conversion systems. Schemes for electric generations, generator control, load control, Grid Connected Wind Energy Conversion System,

Unit 4: Fuel Cells, Energy storage systems:

Introduction, Types of fuel Cells, Energy conservation, The structure of Power Storage Devices, Flywheels, Compressed Air Energy storage systems, Battery Storage, Applications of Energy storage systems

Unit 5: Converters for Distributed Power Generation Systems & Power Quality problems:

Overview of Power Electronics Converters, Bidirectional AC-DC-AC Topologies, Filters, PWM for AC-DC-AC topologies, Control of converters, selection and sizing of the Converters, Matrix converter, and Multilevel Converters, Power Quality Issues.

Reference Books:

1. Mukund R. Patel, "Wind and Solar Power Systems: Design, Analysis, and Operation, Second Edition", CRC Taylor & Francis, 2006.
2. J.A. Duffie and W.A. Beckman, "Solar Engineering of Thermal Processes", Second Edition, John Wiley, New York, 1991.
3. D.Y. Goswami, F. Kreith and J.F. Kreider, "Principles of Solar Engineering", Taylor and Francis, Second Edition, 1999.
4. D. D. Hall and R.P. Grover, "Bio-Mass Regenerable Energy, John Wiley, Newyork, 1987.
5. Haitham Abu-Rub, Mariusz Malinowski, Kamal Al-Haddad, "Power Electronics for Renewable Energy Systems, Transportation and Industrial Applications", Wiley Publications, 2014.
6. Ewald F. Fuchs, Mohammad A.S. Masoum," Power Conversion of Renewable Energy Systems," Springer, 2012.

Course Outcomes:

CO	Doctoral candidates will be able to:
CO1	Understand the usage of power electronic converters in renewable energy power applications.

CO2	Design grid-connected and off-grid connected converter systems for renewables.
CO3	Understand the national and international safety standards relevant to grid-connected inverters for renewable applications.

CO-PO & PSO Correlation:

Subject: Power Electronics Applications in Renewable Energy

(**SOE-P-EE103(1)**)

	Program Outcomes						**PSOs**	
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**
CO1:	2	2	2			1	2	
CO2:	3	2	2			1	3	2
CO3:	3	2	3			1	2	3

Note: 1: Low 2.: Moderate 3: High

Programme: **PhD**			
Name of the Course:	**Soft Computing**	**Course Code:**	**SOE-P-EE103(2)**
Credits :	**3**	**No of Hours:**	**5 hrs./week**
Max Marks:	**100**		

Course Description

Soft computing is an emerging approach to computing that parallels the remarkable ability of the human mind to reason and learn in an environment of uncertainty and imprecision. Soft computing is based on inspired biological methodologies such as genetics, evolution, ant behaviors, particle swarming, human nervous systems, etc. Soft computing provides solutions when we don't have any mathematical modeling of problem-solving (i.e., algorithm), need a solution to a complex problem in real-time, is easy to adapt to the changing scenarios,s and can be implemented with parallel computing. It has enormous applications in many application areas such as medical diagnosis, computer vision, handwritten character reconditions, pattern recognition, machine intelligence, weather forecasting, network optimization, VLSI design, etc.

Course Objectives:

1. To understand the concepts of fuzzy sets, knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy logic control.
2. To understand the basics of an evolutionary computing paradigm known as genetic algorithms and their application to engineering optimization problems.
3. To understand the fundamental theory and concepts of neural networks, neuro-modeling, several neural network paradigms, and its applications.

Syllabus:

UNIT 1:Basics of Soft Computing:

Introduction to Soft Computing, Hard Computing, Soft Computing Characteristics, Hard Computing Vs. Soft Computing, Hybrid Computing.

UNIT 2: Fuzzy Logic:

Introduction to Fuzzy Logic, Introduction to Crisp Sets and Fuzzy Sets, Basic Fuzzy Set Operation (Union, Intersection, Complement and Other Fuzzy Algebraic Operations) and Approximate Reasoning, Fuzzy Membership Functions, Fuzzy Relations, Fuzzy Propositions, Fuzzy Implications, Fuzzy Inferences Such as Mamdani Minimum and Larsen Product, Different Defuzzification Techniques like CoG, CoA, CoS, Height Methods.

UNIT 3:Applications of Fuzzy Logic:

Fuzzy Logic Controllers, Architecture of Fuzzy Logic Controllers, Knowledge-Based Control, Fuzzy Knowledge and Rule Bases, Mamdani type and Takagi-Sugeno type Fuzzy Controllers, Fuzzy PI and Fuzzy PD Controllers.

Unit 4: Genetic Algorithm:

Solving Optimization Problems, Basic Concept of Genetic Algorithm and Detail Algorithmic Steps, Adjustment of Free Parameters, GA Operators: Encoding, GA Operators: Selection, GA Operators: Crossover, GA Operators: Mutation, Multi-Objective Optimization, Pareto Optimality.

Unit 5:Neural Networks:

Concept of Artificial Neural Networks and Its Basic Mathematical Model, ANN Architecture, Feed-Forward Multilayer Perceptron, Learning and Training The Neural Network, Applications of ANN, Recurrent Neural Networks, Radial Basis Function Network

Text Books:

1. An Introduction to Fuzzy Control: Dimiter Driankov, Hans Hellendoorn, Michael Rein Frank, Springer-Verlag Berlin Heidelberg; 2nd Edition
2. Intelligent Systems and Control: Principles and Applications: Laxmidhar Behera, Indrani Kar, Oxford University Press.
3. Genetic Algorithms in Search, Optimization, and Machine Learning: David E. Goldberg, Addison-Wesley Longman Publishing Co.; 1st Edition
4. Introduction to Artificial Neural Systems: Jacek M. Zurada, Jaico; 1st Edition

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Reference Books:

1. Fuzzy Logic with Engineering Applications: Timothy J. Ross, Wiley; 3rd Edition.
2. Neural Networks and Learning Machines: Simon S. Haykin, Pearson; 3rd Edition.
3. Optimization for Engineering Design: Algorithms and Examples: Kalyanmoy Deb, Prentice Hall India Learning Private Limited; 2nd Edition

Course Outcomes:

CO	Doctoral candidates will be able to:
CO1	Understand the difference between hard computing and soft computing
CO2	Understand the fuzzy set theory and can differentiate between crisp and fuzzy sets
CO3	Learn different applications of fuzzy logic, such as fuzzy logic controllers
CO4	Understand the concept of evolutionary optimization techniques such as genetic algorithms.
CO5	Understand the working of artificial neural networks and applications of ANN for problem-solving.

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CO-PO & PSO Correlation:

Course Name : Soft Computing (SOE-P-EE103(2))								
	Program Outcomes						PSOs	
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**
CO1:	2	2	2			1	2	
CO2:	3	2	2			1	3	2
CO3:	3	2	3			1	2	3
CO4:	3	2	3			1	2	3
CO5:	3	2	1			1	2	3

Note: 1: Low 2.: Moderate 3: High

Programme: **PhD**			
Name of the Course:	**Computer Aided Power System Analysis**	**Course Code:**	**SOE-P-EE103(3)**
Credits :	**3**	**No of Hours:**	**5 hrs./week**
Max Marks:	**100**		

Course Description:

To emphasize the fundamentals of Power System analysis while employing a Computer for computational purposes. This course will handle three basic problems of short circuit studies, flow studies and the transient stabilities which are computationally intensive. At the end the student will be in a position to develop his own program for such purposes and feel more confident while using various software available in the field.

Course Objectives:

To introduce computer applications in the analysis of power systems

1. To understand the solution methods and techniques used in power system studies.
2. To understand the concepts of per-unit system and modeling of power system.
3. To learn the concepts of power flow analysis.
4. To learn the concepts of unit commitment and hydro-thermal coordination.
5. To understand the concepts of state estimation and contingency analysis

Syllabus:

Unit-1: Power System Overview:

Overview of Graph theory -tree, co-tree and incidence matrix, Development of network matrices from Graph theoretic approach. Review of solution of Linear System of equations by Gauss Jordan method, Gauss elimination, LDU factorization. Bus

Reference Frame: Injections and Loads. Zbus and Y bus. Formulation of Bus Impedance matrix for elements without Mutual Coupling. Review of basic concepts- per unit systems, ac circuits, phasors, power system structure and topology; System Modeling: From Detailed to Approximate Including Their Controls: Automatic Voltage Regulator (AVR): Exciter types, Exciter Modeling, Generator Modeling, Static and Dynamic analysis of the AVR Loop, AVR Root Loci, Stability Compensation, Effect of Generator Loading. Automatic Load Frequency Control (ALFC): Steady state and dynamic analysis in frequency domain for multi-area power system. Transmission systems: transformers and lines, including distributed parameter models Loads: RL, motor drives and aggregated models.

Unit-2: Optimal Power Flow:

Power flow analysis, Optimal power flow, Solution of OPF by Gradient method, Newton's method, LP method, Security constrained OPF, Continuation power flow, Sparse matrix techniques for large scale system problems.

Unit-3: Scheduling Problems:

Unit commitment of generators, Hydro-thermal coordination- hydrological coupling between hydro power stations, power balance and discharge equations, formulation of the operational planning problem, pumped storage units and their scheduling, Generation with limited energy supply, Probabilistic production simulation.

Unit-4: Security and Contingency Analysis:

Power System Security, Contingency analysis, sensitivity factors, preventive & corrective measures, State Estimation in Power Systems, Weighted lest square estimation, Estimation in AC network, Orthogonal decomposition.

Unit-5: Power System Stability:

Stability Studies Network formulation for stability studies for different types of loads, (constant impedance, constant current and constant power loads), digital computer solution of swing equation for single and multi-machine cases using Runge-Kutta and predictor-corrector methods, effects of exciter and governor on transient stability Fast Transient Stability Solution.

Text Books:

1. A. J. Wood and B. F. Wallenberg, "Power generation, operation and control", WileyInterscience, 2nd Edition, 1996.
2. G.W. Stagg and A.H. El-Abiad, computer Methods in Power system Analysis Mc Graw Hill, 1971
3. G.L. Kusic, Computer Aided Power System Analysis Prentice Hall International, 1986

References Books:

1. L.P. Singh, Advanced Power System Analysis and Dynamics, Wiley Eastern
2. J. Arrillage and C.P. Arnold "Computer Analyzing Power Sysem" john Wiley Singapore 1990.
3. P. Kundur "Power System Stability and Control" Mc Graw Hill, New York 1993.
4. A.R. Bergen and V.Vittal, "Power System Analysis" Englewood, Cliff, N.J. Prentice Hall, 2000.

Course Outcomes:

CO	Doctoral candidates will be able to:
CO1	understand modeling of power systems.
CO2	calculate steady state voltages and bus angles given the load and generation using load flow calculation methods i.e. GSLF, NRLF, and FDLF.
CO3	analyze hydro-thermal coordination problems.
CO4	carry out contingency analysis and ranking.

CO-PO & PSO Correlation:

Course Name : Computer Aided Power System Analysis (SOE-P-EE103(4))								
	Program Outcomes						**PSOs**	
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**
CO1:	2	2	2			1	2	
CO2:	3	2	2			1	3	2
CO3:	3	2	3			1	2	3
CO4:	3	2	3			1	2	3

Note: 1: Low 2.: Moderate 3: High

Programme: **PhD**			
Name of the Course:	**Power System Optimization**	**Course Code:**	**SOE-P-EE104(1)**
Credits :	**3**	**No of Hours:**	**5 hrs./week**
Max Marks:	**100**		

Course Description:

To understand the operation of power networks from an optimization perspective. How the mathematical tools and computational methods are used for the design, modeling, planning, and real-time operation of power grids. It also emphasizes on the application of the conventional and emerging stochastic optimization algorithms for solving power system economics problems.

Course Objectives:

1. To understand the concepts of economic load dispatch, emission load dispatch and optimal hydrothermal scheduling of power system.
2. To learn the different classical and intelligent optimization methods to solve power system problems.
3. To learn the efficient methods of problem solving for load dispatch and hydro thermal scheduling and active and reactive power balance.
4. To understand the multi-objective optimization methods in power system problem solving.

Syllabus:

Unit-1: Introduction to Optimization:

Convex sets and functions, Least-squares, linear, and quadratic optimization, Formulation of objective function, incorporating constraints in objective function.

Gradient-based methods: Newton-Raphson method, Bisection method, Secant method, Computer programmes. Optimality criteria, Unidirectional search, direct search methods: Evolutionary optimization method, Simplex search method, Hooke-Jeeves pattern search method, Kuhn Tucker Condition, Rosen's Gradient projection method, Penalty function method. Genetic Algorithm, Differential Evolution and Particle Swarm Optimization.

Unit-2: 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

Unit-3: Optimal Hydrothermal 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.

Unit-4: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.

Unit-5: Stochastic Multi Objective Generation Scheduling:

Introduction, multi-objective stochastic optimal thermal power dispatch- $\in$ -constant method, multi-objective stochastic optimal thermal power dispatch- The surrogate worth trade-off method, multi-objective stochastic optimal thermal power dispatch- weighing method, stochastic economic-emission load dispatch, multiobjective optimal thermal dispatch- risk/dispersion method, stochastic multi-objective short term hydro thermal scheduling, stochastic multi -objective long-term hydro thermal scheduling.

Text Books:

1.Kothari D.P, Dhillon J.S, "Power System Optimization" – PHI Private Limited.

2.James A Momoh, "Electric Power System Application of Optimization", CRC Press

3.Taha,H.A., Operations Research –An Introduction, Prentice Hall of India,2003.

References Books:

1.S.S. Rao, "Engineering Optimization-Theory and Practice Power", 2009 John Willey & Sons, New York, USA.

2.A.D. Belegundu, T.R. Chandrupatla, "Optimization Concepts and Applications in Engineering", Cambridge, University press.

3.Fox, R.L., „Optimization methods for Engineering Design-, Addition Welsey, 1971.

Course Outcomes:

CO	Doctoral candidates will be able to:
CO1	Understand optimization problems, types and applications.
CO2	know the concept of load dispatch, hydrothermal scheduling problems and classical and intelligent solutions.
CO3	solve single or multi optimization of power systems like cost and emission or both in a thermal or hydro thermal power system.
CO4	analyze operation and control of hydro thermal power systems.

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CO-PO & PSO Correlation:

Course Name : Power System Optimization (SOE-P-EE104(1))								
	Program Outcomes						**PSOs**	
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**
CO1:	2	2	2			1	2	
CO2:	3	2	2	2		1	2	1
CO3:	3	2	3	2		1	2	1
CO4:	3	2	3		1	1	2	1

Note: 1: Low 2.: Moderate 3: High

Programme: **PhD**			
Name of the Course:	**Advanced Power System Protection**	**Course Code:**	**SOE-P-EE104(2)**
Credits :	**3**	**No of Hours:**	**5 hrs./week**
Max Marks:	**100**		

Course Description:

To impart advanced knowledge in static & microprocessor based protective relaying which have replaced / replacing the old electromagnetic relays and to a certain extent even the static relays. This also includes the protection schemes of long transmission lines. At the end of the course students will be confident to handle modern Power System relaying systems.

Course Objectives:

1. To understand the concept of using digital computers for power system relaying.
2. To understand new development in the role of a potential user or manufacturer of computer relays.
3. To give a brief idea about wide area measurement systems

Syllabus:

Unit-1:Introduction:

Relaying Practices: Introduction to protection systems, Functions of a protection system, Protection of transmission lines, Transformer, reactor & generator protection, Bus protection, Performance of current & voltage transformers. Comparators Transfer impedance, mixing circuits, amplitude and phase comparators and their duality, static realization of amplitude and phase comparators, multi-input comparators. Static Relays Basic construction, input-output devices, merits and demerits of static relays,

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application of solid state devices.

Unit-2: Computer Relaying:

Development of computer relaying, Historical background, Expected benefits of computer relaying, Computer relay architecture, Analog to digital converter, Anti-aliasing filter, Substation computer hierarchy,

Unit-3: Mathematical Basis for Protective Relaying Algorithms:

Introduction, Fourier series, Other orthogonal expansion, Fourier transform, Use of Fourier transform, Discrete Fourier transform, Introduction to probability & random processes, Random processes, Kalman filtering. Transmission Line Relaying: Introduction, Sources of error, relaying as parameter estimation, Beyond parameter estimation, Symmetrical component distance relay, protection of series compensated lines.

Unit-4: Protection of Transformers, Machines & Buses:

Introduction, Power transformer algorithms, Generator protection, Motor protection, Digital bus protection. Hardware Organization in Integrated Systems: The nature of hardware issues, Computers for relaying, The substation environment, Industry environmental standards, Countermeasures against EMI, Supplementary equipment, Redundancy & backup, Servicing, training & maintenance.

Unit-5:System Relaying & Control:

Introduction, Measurement of frequency & phase, Sampling clock synchronization, Application of phasor measurements to state estimation, Phasor measurement in dynamic state estimation, Monitoring. Developments In New Relaying Principles: Introduction, Traveling waves on single-phase lines, Traveling waves on three-phase lines, Traveling waves due to faults, Directional wave relays, Traveling wave distance relay, Differential relaying with phasors, Traveling wave differential relays, Adaptive relaying, Examples of adaptive relaying, fault location algorithms, Other recent developments.

Text Books:

1.A.G. Phadke and J.S. Thorp, "Computer Relaying for Power Systems", John Wiley and Sons, 1994.

2.Stanley H. Horowitz and Arun G. Phadke, "Power System Relaying", Research Studies

Press Ltd., England. J.L. Blackburn, “Protective, Relaying”, Marcel Dekker, Inc., 1987.

3."Computer Relaying", IEEE Tutorial Course (79EH0148-7-PWR), IEEE Power Engineering Society, NJ, 1979

References Books:

1.J.S. Lewis Blackburn (Editor) “Protective Relaying Principles & Applications” Third Edition, CRC Press 2007.

2. A.T. John and S.K. Salman “Digital Protection of Power System” Peter Paregrinus, IEE Pub 1995.

3.A.R. Van C. Warrington, “Protective Relays- Their theory and practice Vol.I II”, John Wiley Sons, 1977

Course Outcomes:

CO	Doctoral candidates will be able to:
CO1	understand the important operating principle, design and planning of the protective system in a power system.
CO2	exposure to traditional electro-mechanical relaying principle as well as to modern numerical relaying basics.
CO3	know about wide area measurement systems.

CO-PO & PSO Correlation:

Course Name : Advance Power System Protection (SOE-P-EE104(2))								
	Program Outcomes						**PSOs**	
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**
CO1:	2	2	2	1	1	1	2	1
CO2:	3	2	1			1	1	2
CO3:	3	2	3	1	1	1	1	1

Note: 1: Low 2: Moderate 3: High

Programme: **PhD Coursework**			
Name of the Course:	**Power Electronics Devices and Circuits**	**Course Code:**	**SOE-P-EE104(3)**
Credits :	**3**	**No of Hours:**	**5 hrs./week**
Max Marks:	**100**		

CourseDescription:

The subject deals with the conversion, control and switching of electrical energy for power applications and playing a major role in revolutionizing the industrial processes. It provides the essential link between the micro level of electronic controllers and megawatt level of industrial power and processes requirements. It has applications within the whole field of the electrical energy system

CourseObjectives:

The subject aims to provide the student with:-

1. To understand and develop the firing circuit requirement for different power semiconductor devices used as switches.
2. To understand the rating specification for design and development of the protection circuits for Semiconductor devices.
3. To analyze the effect of controlled and uncontrolled converters in Power system and their mitigation.
4. To design and develop the commutation circuits for semi controlled power semiconductor devices.
5. To understand the concepts of different types of AC-DC, DC-DC & DC-AC controlled converters for Industrial applications.

Syllabus:

UNIT-1: Thyristor family & Switch Realization: Survey of power semiconductor devices, Silicon controlled rectifier (SCR), construction and principle of operation, two-transistor

analogy, static and dynamic characteristics, gate characteristics, ratings, series and parallel operation of SCRs, over voltage and over current protections, protection against high di/dt and high dv/dt, Power diode, SCR, GTO, LASCR, RCT, SITH, BJT, MOSFET, IGBT etc., Switching losses, driver circuits, protection, cooling, application.

UNIT-2:Controlled Rectifiers (Converters):

Single Phase / Three Phase, Half wave / full wave, half controlled /fully controlled converters with R, RL and RLE loads, Continuous and discontinuous current operations- Evaluation of performance parameters. Effects of source inductance, Power factor improvement techniques, twelve pulse converters, Dual converters.

UNIT-3:DC- DC Converters:

Principle of operation of buck, boost, buck-boost, Cuk, fly back, forward, push-pull, half bridge, full bridge Converters with the continuous and discontinuous operation, Input & output filter design, multi-output boost converters, diode rectifier based boost converters. State space analysis of regulators.

UNIT-4:Design:

Design considerations: Snubber circuit, a driver circuit, temperature control and heat sink, materials, windings. The design of converter and chopper circuits. Triggering circuits for converter and choppers. MMF equations, magnetic. The design of transformers and inductors.

UNIT-5:Invertors:

Classification of inverters, voltage source inverter, current source inverter, series resonant inverter, modified series resonant inverter, parallel inverter, bridge inverter, auxiliary commuted single-phase inverter, complementary commuted singe-phase inverter, and three-phase inverter, Cyclo-converters: the basic principle of operation, step-up and step down single-phase to single-phase Cyclo-converter.

Recommended Text books and Reference books:

1. M. H. Rashid, "Power Electronics - Circuits, Devices and Applications", P.H.I Private Ltd. New Delhi, Second Edition, 1994.

2. "Power Electronics" by Dr. P. S. Bimbhra, Khanna Publishers, 5th Edition, 2012.

3. Bimal K Bose, “Modern Power Electronics and AC Drives” PHI

4. “A text book of power electronics”, S.N Singh, Dhanpat Rai.

5. Power electronics, Murthy, Oxford.

6.“Power electronics”, P. C. Sen, TMH.

7. R W Erickson and D Makgimovic, “Fundamental of Power Electronics” Springer, 2nd Edition.

8. P. T. Krein, “Elements of Power Electronics”, OUP

Course Outcomes:

CO	Doctoral candidates will be able to:
CO1	To gain knowledge on basic DC-DC converters and their operation under continuous /discontinuous modeof conduction for RLE loads.
CO2	To identify and formulate the requirements for four quadrants operation of DC motor.
CO3	To differentiate and understand the significance of various commutation circuits and their consequence on device stress.
CO4	To understand the principle of DC-AC conversion and the different topology for three phase to three phase and single phase to single phase DC-AC conversion.

CO-PO & PSO Correlation:

Course Name : Power Electronics Devices and Circuits (SOE-P-EE104(3))									
	Program Outcomes						PSOs		
Course Outcomes	1	2	3	4	5	6	1	2	3
CO1:	3	3	2			2	3	3	
CO2:	3	3	2				3	2	
CO3:	3	3	3			1	3	2	
CO4:	3	1				1	3	2	

Note:1: Low 2: Moderate 3: High

Programme: **PhD**			
Name of the Course:	**Power Electronics Controlled Electric Drives**	**Course Code:**	**SOE-P-EE104(4)**
Credits :	**3**	**No of Hours:**	**5 hrs./week**
Max Marks:	**100**		

Course Description:

To develop the skills and critical fundamentals in the area of modern days Electrical Drives and to understand the importance of Power Electronics converters, Electrical machines and Control systems in the Drives applications point of view.

CourseObjectives:

The subject aims to provide the student with:

1. To understand various operating regions of the AC motor and DC motor drives.
2. To understand the speed control of induction motor drive from the rotor side.
3. To understand the field oriented control of electrical machines.
4. To understand the control of synchronous motor drives.

Syllabus:

UNIT-1:Review of Conventional Drives

Introduction of Electrical Drives-speed –torque relation, Steady state stability, methods of speed control, braking for DC motor – Multi quadrant operation, Speed torque relation of AC motors, Methods of speed control and braking for Induction motor, Synchronous motor.

UNIT-2:Converter Control of DC Drives

Analysis of series and separately excited DC motor with single phase and three phase converters operating in different modes and configurations.

Chopper Control of DC Drives

Analysis of series and separately excited DC motors fed from different choppers for both time ratio control and current limit control, four quadrant control.

UNIT-3:Design of DC Drives:

Single quadrant variable speed chopper fed DC drives, four quadrants variable speed chopper fed DC Drives, Single phase/ three phase converter, Dual converter fed DC Drive, current loop control, Armature current reversal, Field current control, Different controllers and firing circuits, simulation.

UNIT-4: Inverter fed AC Drives

Analysis of different AC motor with single phase and three phase inverters Operations in different modes and configurations., Problems and strategies.

Cyclo-Converter fed AC Drives

Analysis of different AC motor with single phase and three phase cyclo-converters Operations in different modes and configurations, Problems and strategies.

AC Voltage Controller fed AC Drives

Speed Control and braking, Analysis of different AC motor with single phase and three phase ac voltage controllers. Operations in different modes and configurations

UNIT-5: Control and Estimation of electric Drives

Induction motor: Small signal models, scalar control, FOC control, sensor less control, DTC, adaptive control. Synchronous motor: sin SPM, synchronous reluctance machines, sin IPM machines, trapezoidal SPM, wound fitted SM, sensor-less operation, switched reluctance machines, Dynamics and Modelling of AC Drives.

Recommended Text books and Reference books:

1. Bimal.K. Bose, “Power Electronics and Variable frequency drives”, Standard Publishers Distributors, New Delhi, 2000 Page of 13 18.

2. Murphy J.M.D, Turnbull, F.G, “Thyristor control of AC motor, Pergamon press, Oxford, 1988.

3. M. H. Rashid, "Power Electronics - Circuits, Devices and Applications", P.H.I Private Ltd. New Delhi, Second Edition, 1994

4. N. Mohan et.al. "Power Electronics- Converters, Applications and Design", John Wiley & Sons (Asia) Private Ltd., Singapore, 1996.

5. Bimal K Bose, “Modern Power Electronics and AC Drives” PHI 6. R. Krishnan, “Electric motor drives: modelling, analysis and control, Pearson.

Name of Reference Books:

1. Dubey G.K. “Power Semiconductor controlled drives”, Prentice Hall inc, A division of Simon and Schester England cliffs, New Jersey 1989.

2. Dubey G.K. “Power Semiconductor controlled drives”, Prentice Hall inc, A division of Simon and Schester England cliffs, New Jersey 1989.

3. Sen. P.C. “Thyristor DC Drives”, John Wiley and sons, NewYork, 1981.

4. Subramanyam, V. “Electric Drives – Concepts and applications”, Tata McGraw Hill Publishing Co., Ltd., New Delhi 2003.

Course Outcomes:

CO	Doctoral candidates will be able to:
CO1	Ability to acquire and apply knowledge of mathematics and converter/machine dynamics in Electrical engineering.
CO2	Ability to formulate, design, simulate power supplies for generic load and for machine loads.
CO3	Ability to perform experiments towards research

CO-PO & PSO Correlation:

Course Name : Power Electronics Controlled Electric Drives (SOE-P-EE104(4))									
	Program Outcomes						**PSOs**		
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
CO1:	**3**	**3**	**2**			**2**	**3**	**3**	
CO2:	**3**	**3**	**2**				**3**	**2**	
CO3:	**3**	**3**	**3**			**1**		**2**	

Note: 1: Low 2: Moderate 3: High

Programme: **PhD Coursework**			
Name of the Course:	**Solar Photovoltaic Technology**	**Course Code:**	**SOE-P-EE104(5)**
Credits :	**3**	**No of Hours:**	**5 hrs./week**
Max Marks:	**100**		

Course Description:

This course elaborates regarding current trends in solar architecture, All the aspects of PV technology. It helps to develop basic understanding related to fabrication and characterization of different types of solar cells. It explains the state of art in the field of solar cells materials and solar cells. This course provides the introduction of solar photovoltaic system design and solar photovoltaic system testing.

Course Objectives:

The objective of this course is to:

1. Elaborate solar architecture and following key concepts: Solar Radiation, Sun Angles, and Importance of Sun Angles day lighting.
2. Introduce conversion of Solar energy into Electricity by PV cells and its performance.
3. Detail the various technology involve for solar cell manufacturing.
4. Design process and optimization of solar photovoltaic systems.
5. Test and performance assessment of Solar PV.

Syllabus:

UNIT-1: Earth & Sun Relationship:

Earth & Sun Relation: Solar Angles, Day length, Angle of Incidence on Tilted Surface, Sunpath Diagram. Available Solar Radiation: Extraterrestrial Characteristics, Effect of

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EarthAtmosphere, Measurement and Estimation on Horizontal and Tilted Surface, SolarRadiations Characteristics.

UNIT-2: Solar Cells:

Conversion of Solar energy into Electricity - Photovoltaic Effect, Equivalent Circuit of theSolar Cell, Analysis of PV Cells: Dark and illumination characteristics, Figure of merits of solar cell, Efficiency limits, Variation of efficiency with band-gap and temperature,Efficiency measurements, Effect of temperature on Cell performance, Thermo photovoltaic effect, Types of solar cells, Recent developments in Solar Cells

UNIT-3: Fabrication Technology for Solar Cells:

Si solar cells, CdTe solar cells, Cu(In,Ga)Se2, GaAs solar cells, Organic solar Cells,

Perovskite solar cells, High efficiency multi-junction solar cell. Technologies for the

fabrication of thin film cells: Thermal evaporation, CVD, CSS etc.

UNIT-4: Solar Photovoltaic System Design:

Solar cell array system analysis and performance prediction, Shadow analysis: Reliability,Solar cell array design concepts, PV system design, Design process and optimization:Detailed array design, Voltage regulation, Maximum tracking, Quick sizing method, Array protection.

UNIT-5: Solar Photo Voltaic System Testing:

Sun Simulator, Testing and performance assessment of Solar PV generator, Electronic

Control and Regulation, Power Conditioning, Converters and inverter, Concentrating system,System design and configuration.

Text Books:

1. Fundamentals of Solar Cells:PV Solar Energy Conversion: AL Fahrenbruch and RH Bube, Academic Press, New York, 1983

2. Solar Cells and their Applications: Lewis M. Fraas, Larry D. Partain, John Wiley and Sons, 2nd ed., New York, 1995

3. Photovoltaic Materials: RH Bube, Imperial College Press, London, 1998

4. Solar Cell Array Design Handbook: HS Rauschenbach, Van Nostrand Reinfold Company, New York, 1980

5. Stand Alone PV Systems: A Handbook of Recommended Design Practices, Report No SAND 87-7023, Sandia National Lab USA

Reference Books:

1. Terrestrial Solar Photovoltaic: T Bhattacharya, Narosa Publishers Ltd, New Delhi,1998

2. Photovoltaic Systems Engineering: R Messenger and J Vnetre, CRC Press,2020.

3. Principles of Solar Engineering: F Kreith and JF Kreider, McGraw-Hill (1978)

4. Renewable Energy Resources: J Twidell and T Weir, Taylor and Francis (Ed), New York, USA, 2006

Course Outcomes:

CO	Doctoral candidates will be able to:
CO1	Understand the solar architecture and various terminology.
CO2	Analysis of PV Cells and its characteristics.
CO3	Understand the theoretical knowledge about fabrication of solar cells.
CO4	Analyze the design and development of PV modules, arrays and PV systems.
CO5	Understand testing and performance assessment of Solar PV generator.

CO-PO & PSO Correlation:

Course Name : Solar Photovoltaic Technology (SOE-P-EE104(5))											
	Program Outcomes								**PSOs**		
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**			**1**	**2**	
CO1:	3	3	2						3	1	
CO2:	3	3	1						3	2	
CO3:	2	3	3	2	2				3	2	
CO4:	3	3	3	2	3	3			2	2	
CO5:	3	3	2		2	3			3	3	

Note: 1: Low 2.: Moderate 3: High

Programme: **PhD**			
Name of the Course:	**Introduction to Python**	**Course Code:**	**SOE-P-EE104(6)**
Credits :	**3**	**No of Hours:**	**5 hrs./week**
Max Marks:	**100**		

Course Description:

The course will embed the quality to design, write, debug and run programs encoded in the Python language, and to understand the basic concepts of problem solving approach and role of computation of software development technology. The course will emphasize on python programming fundamentals, various data types, conditional and looping operations, add on modules such as numpy, panda, scipy. The course also discusses the fundamentals of machine learning algorithms and their implementation using Python.

Course Objectives:

The subject aims to provide the student with: -

Familiarizing with the python programming fundamentals.

1. Understanding the role of computation for problem solving problems.
2. The ability to learn the semantics and tools for the python programming language.
3. Application of python programming to advanced field of machine learning.

Syllabus:

UNIT-1: Introduction to Python

History, Features, Programming Concepts, Identifiers, Keywords, Statements and Expressions, Variables, Operators, Data Types, Indentation, Comments, Reading Input,

Output, Type Conversions.

UNIT-2: Loops and Strings

If-else, Loops – For, while; break continue, String manipulations – Basic String Operations, Accessing Characters in String by Index Number, String Slicing and Joining, Formatting Strings, immutability, string functions and methods.

UNIT-3: Python Building Blocks

Functions - Defining, invoking functions, passing parameters, Lists – list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters,

Tuples - tuple assignment, tuple as return value, Sets - Concept of Sets, creating, initializing and accessing the elements, operations, Dictionaries - Concept of key-value pair, creating, initializing and accessing the elements in a dictionary, operations and methods, Modules - Importing module, Math module, Random module, Packages.

UNIT-4: Python for Analytics

Use of OOPs Concepts and Libraries – NumPy – Introduction, creating objects, operations on objects, Pandas – Introduction, series, Data Frame, Panel, operations and statistical functions, SciPy – Introduction, Basic functionality, Cluster, Constants, Statistical functions, plotting with matplotlib.

UNIT-5: Introduction to Machine Learning

Mean, Median, Mode, Standard Deviation, Data Distribution and Normal Data Distributions, Regression – Linear, Polynomial, Multiple regression, Scale, Train/Test– Evaluate Model, operations on Data Sets.

Text Books

1. Introduction to Computation and Programming using Python, by John Guttag, PHI Publisher

2. Python Programming using problem solving Approach by Reema Thareja, Oxford University, Higher Education Oxford University Press; First edition (10 June 2017),ISBN-10: 0199480173

Reference Books:

1. Data Structures and Algorithms in Python by Michael T Goodrich and Robertto Thamassia, Micheal S Goldwasser, Wiley Publisher (2016)

2. Introduction to Machine Learning with Python, A Guide for Data Scientists, by Andreas C. Müller and Sarah Guido, O'Reilly (2017), ISBN: 9781449369415

Course Outcomes:

CO	Doctoral candidates will be able to:
CO1	Understand the concepts of evolution of python programming language.
CO2	Analyze the design issues involved in various constructs of python programming language.
CO3	Comprehend the concepts of object oriented languages, functional and logical python programming language
CO4	Analyze the methods and tools to define syntax and semantics of python.
CO5	Apply the concepts and identify the issues involved in other advanced features of programming languages on various advanced fields of research.

CO-PO & PSO Correlation:

Course Name : Introduction to Python (SOE-P-EE104(6))								
	Program Outcomes						**PSOs**	
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**
CO1:	**3**	**1**					**1**	
CO2:	**3**	**3**					**3**	**1**
CO3:	**3**	**3**					**2**	
CO4:	**3**	**1**					**1**	
CO5:	**2**	**3**	**1**				**3**	**1**

Note: 1: Low 2.: Moderate 3: High