Academic Program: PG

Academic Year 2020-21 Syllabus

III & IV Semester M.Tech

Power Systems Engineering

SHRI DHARMASTHALA MANJUNATHESHWARA COLLEGE OF ENGINEERING & TECHNOLOGY,
DHARWAD – 580 002

(An Autonomous Institution recognized by AICTE & Affiliated to VTU, Belagavi)

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SDM College of Engineering & Technology, Dharwad

It is certified that the scheme and syllabus for III & IV semester M.Tech in Power systems Engineering is recommended by the Board of Studies of Electrical and Electronics Engineering Department and approved by the Academic Council, SDM College of Engineering &Technology, Dharwad. This scheme and syllabus will be in force from the academic year 2019-20 till further revision.

Principal Dean (Academic Program) Chairman BoS & HoD

SDM College of Engineering & Technology, Dharwad
Department of Electrical Engineering

*(Our motto: Professional **C**ompetence with **P**ositive **A**ttitude)*

College Vision and Mission

Vision:

To develop competent professionals with human values.

Mission:

1. To have contextually relevant Curricula.
2. To promote effective Teaching Learning Practices supported by Modern Educational Tools and Techniques.
3. To enhance Research Culture.
4. To involve Industrial Expertise for connecting classroom content to real life situations.
5. To inculcate Ethics and impart soft-skills leading to overall Personality Development.

SDMCET- Quality Policy

- In its quest to be a role model institution, committed to meet or exceed the utmost interest of all the stake holders.

SDMCET- Core Values

- Competency
- Commitment
- Equity
- Team work and
- Trust

Department Vision and Mission

Vision:

To develop globally acceptable Electrical and Electronics Engineering professionals with human values.

Mission:

1. Adopting the state of the art curricula.
2. Practicing effective and innovative teaching-learning methodologies.
3. Initiating complementary learning activities to enhance competence.
4. Inculcating positive attitude and commitment to society.

Program Educational Objectives (PEOs):

The Program Educational Objectives (PEOs):

I. To prepare graduates who will be successful professionals in industry, government, academia, research, entrepreneurial pursuit and consulting firms

II. To prepare graduates who will contribute to society as broadly educated, expressive, ethical and responsible citizens with proven expertise

III. To prepare graduates who will achieve peer-recognition; as an individual or in a team; through demonstration of good analytical, research, design and implementation skills

IV. To prepare graduates who will thrive to pursue life-long reflective learning to fulfill their goals

Program Outcomes (POs):

PO1: An ability to independently carry out research / investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report / document.

PO3: To demonstrate a degree of mastery over the area of power systems Engineering.

PO4: Exposure to the state of the art practices in the domain of power systems engineering

Scheme of Teaching and Examination

III-Semester M. Tech. (Power Systems Engineering)

Course Code	Course Title	Teaching		Examination				
		L-T-P (Hrs/Week)	Credits	CIE	Theory (SEE)		Practical (SEE)	
				Max. Marks	*Max. Marks	Duration in hours	Max. Marks	Duration in hours
18PEPSC300	FACTS Controllers	4-0-0	4	50	100	3		
18PEPSEXXX	Elective course-VII	4-0-0	4	50	100	3.		
18PEPSL301	Internship in industry/ R&D organization / Elective course-VIII **	** 2-4 weeks during vacation after 2nd Sem./ 3-0-0	3	50/50	- /100	-/3	50/-	3/-
18PEPSL302	Project Phase-I***	0-0-15	9	50			50	3
Total		**8/11--0-15**	**20**	**200**	**200/300**		**50**	

CIE: Continuous Internal Evaluation **SEE**: Semester End Examination

L: Lecture **T**: Tutorials **P**: Practical

* SEE for theory courses is conducted for **100 marks** and reduced to **50 marks**.

** The students are expected to undergo training in industry for a period of ***2 - 4 weeks*** during the vacation immediately after completion of II Semester examination. A faculty is to be allotted to guide the student. A committee consisting of three faculty members shall evaluate the work carried out and the knowledge the students have acquired**.** OR The students can take one elective course if they do not undergo internship.

*** Project phase-I: The students are expected to formulate the problem and carry out the intensive literature survey along with preliminary investigations supporting the project phase-II in IV semester.

Course Code	**Elective Courses**
18PEPSE311	Planning & Management of Deregulated Power Systems
18PEPSE312	Power systems Reliability Engineering
18PEPSE313	Programmable Logic Controllers and Applications

Scheme of Teaching and Examination

IV-Semester M. Tech. (Power Systems Engineering)

Course Code	Course Title	Teaching		Examination				
		L-T-P (Hrs/Week)	Credits	CIE	Theory (SEE)		Practical (SEE)	
				Max. Marks	*Max. Marks	Duration in hours	Max. Marks	Duration in hours
18PEPSL400	Project Phase-II **	0-0-20	22	100	--	--	100	3
Total		**0-0-20**	**22**	**100**	**--**	**--**	**100**	**--**

CIE: Continuous Internal Evaluation **SEE**: Semester End Examination

L: Lecture **T**: Tutorials **P**: Practical

***** SEE for theory courses is conducted for 100 marks and reduced to 50 marks.

****** Project phase-I: The students are expected to work on a project for the full semester in an industry or institution

Total Credits offered for the first year: **46**

Total Credits offered for the Second year: **42**

Credits Distribution:

Particulars	Proposed
Program Core Course	20
Program Electives	28
Laboratory Course	04
Seminar	02
Internship/Training	03
Project	31
Total	**88**

III – Semester M. Tech. (Power Systems Engineering)

18PEPSC300	FACTS Controllers	(4-0-0) 4

Contact Hours: 52

Course Learning Objectives (CLOs):

The power systems interconnection has led to the complexity of operation and control of transmission system. The advent in the semiconductor and consequent power semiconductor technology and also the sophisticated processors have made the Flexible AC Transmission System more relevant in the reliable and secured operation transmission system taking many benefits. This subject gives the students a focused insight of Flexible AC Transmission system. Moreover, the different types of FACTS controllers used in the practical situation and their modeling, design, operation and applications shall be studied in this subject. The students also learn how to make performance comparison of different FACTS controllers.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1 to 4)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Recite the concept of AC power transmission networks and basic types of FACTS Controllers.	3		2
CO-2	Demonstrate the knowledge of power semiconductor devices and their application to the FACTS controllers.	3		1,2
CO-3	Analyze the operation of different types of FACTS controllers.	3		2
CO-4	Use different types of FACTS controllers in the transmission system applications.		4	2

PO's	PO-1	PO-2	PO-3	PO-4
Mapping Level	1.0	1.0	3.0	2.0

Prerequisites: [1] Power systems Analysis [2] Power Transmission & Distribution
[3] Power Electronics [4] Control Systems

Contents:

I. Introduction

Basics of power transmission networks - control of power flow in AC - transmission line- flexible AC transmission system controllers – Basic type of FACTS controllers and definitions. Application of FACTS controllers in transmission and distribution system. **6 Hrs.**

II. AC Transmission Line and Reactive Power Compensation

Analysis of uncompensated AC Line - passive reactive power compensation - compensation by a series capacitor connected at the midpoint of the line - shunt compensation connected at the midpoint of the line - comparison between series and shunt capacitor - compensation by STATCOM and SSSC- some representative examples. **8 Hrs**.

III. Static VAR Compensator

Analysis of SVC, Configuration of SVC, SVC Controllers, harmonics and filtering - protection aspects – modeling of SVC – applications of SVC**. 6 Hrs.**

IV. Thyristor and GTO Controlled Series Capacitor

Introduction - Basic concepts of controlled series compensation operation of TCSC - analysis of TCSC- control of TCSC - modeling of TCSC for stability studies - GTO thyristor controlled series capacitor (GCSC) – Issue sub synchronous resonance with TCSC - Applications of TCSC**. 6 Hrs.**

V. Static Phase Shifting Transformer

General - basic principle of a PST - configurations of SPST improvement of transient stability using SPST - damping of low frequency power oscillations - applications of SPST**. 6 Hrs.**

VI. Static Synchronous Compensator (STATCOM)

Introduction - principle of operation of STATCOM - a simplified analysis of a three phase six pulse STATCOM -- multi-pulse converters Control of type I Converters - multilevel voltage source converters, Comparison between SVC and STATCOM Applications of STATCOM**. 8 Hrs.**

VII. SSSC and UPFC

SSSC-operation of SSSC and the control of power flow –modeling of SSSC in load flow and transient stability. **4 Hrs.**

Unified Power Flow Controller (UPFC) – Principle of operation – modes of operation –applications – modeling of UPFC for power flow studies. **4 Hrs.**

Special Purpose FACTS Controllers: Interline Power Flow Controller - operation and control. **4 Hrs.**

Reference Books:

[1] K. R Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International, 2007.

[2] Narain G Hingorani and L. Gyugyi, "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems", Wiley India, 2011.

[3] Y. H. Song and A. T. Johns, "Flexible AC Transmission System", Institution of Engineering and Technology, 2009.

[4] Mohan Mathur, R., Rajiv. K. Varma, "Thyristor – Based Facts Controllers for Electrical Transmission Systems", IEEE press and John Wiley & Sons, Inc.

18PEPSE311 Planning & Management of Deregulated Power Systems (4-0-0) 4

Contact Hours: 52

Course Learning Objectives (CLOs):

In the competitive environment and current situation around the world Deregulation of power systems is gaining importance. Benefits of deregulation and its after effects are to be learnt. This subject gives the students a focused insight of operating deregulated power systems. Moreover, the different types of transmission open access and pricing issues of various countries shall be studied in this subject. The students also learn how to make power systems reliable in deregulated condition.

Course Outcomes (COs)

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1to 4)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Recite the concept of Deregulation of the Electricity Supply Industry.		3	4
CO-2	Demonstrate the knowledge of Power systems Economic Operation.		1	
CO-3	Analyze the Power systems Operation in Competitive Environment, Transmission Open Access and Pricing Issues	3		2
CO-4	Apply knowledge of Ancillary Services Management in various countries and reliability aspects.			4

PO's	**PO-1**	**PO-2**	**PO-3**	**PO-4**
Mapping Level	**2.0**	**1.0**	**2.5**	**1.0**

Prerequisites: [1] Power systems Analysis [2] Power Transmission &Distribution
[3]Power systems Operation and Control
[4] Power systems planning.

Contents:

I. Deregulation of the Electricity Supply Industry

Introduction, meaning of deregulation, background to deregulation and the current situation around the world, benefits from a competitive electricity market, after effects of deregulation. **8 Hrs**.

II. Power systems Economic Operation Overview

Introduction, economical load dispatch, optimal power flow as a basic tool, unit commitment, formation of power pools. **8 Hrs.**

III. Power systems Operation in Competitive Environment

Introduction, role of independent system operator (ISO), operational planning activities of ISO, Operational planning activities of a Genco. **8 Hrs.**

IV. Transmission Open Access and Pricing Issues

Introduction, power wheeling, transmission open access, cost components in transmission, pricing of power transactions, transmission open access and pricing mechanisms in various countries, developments in international transmission pricing in Europe, security management in deregulated environment, congestion management in deregulation. **10 Hrs.**

V. Ancillary Services Management

Ancillary services and management in various countries, reactive power as an ancillary service. **8 Hrs.**

VI. Reliability and Deregulation

Terminology, reliability analysis, network model, reliability costs, hierarchical levels, reliability and deregulation, performance indicators. **10 Hrs.**

Reference Books:

[1] Kankar Bhattacharya, Math H J Bollan, Jaap E Daalder, “Operation of Restructured Power systems”, Kluwer Academic Publishers, 2001.

[2] Loi Lei Lai, “Power systems Restructuring and Deregulation; Trading, Performance and Information Technology”, John Wiley and Sons, Ltd, 2002

18PEPSE312	Power Systems Reliability Engineering	(4-0-0) 4

Contact Hours: 52

Course Learning Objectives (CLOs):

To give the students' knowledge on how to use reliability analysis as a tool for decision support during planning, design, operation and maintenance of electric power systems in particular electrical distribution systems

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1 to 4)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Describe adequacy and security and evaluate reliability indices using probabilistic processes	1, 2	4	3
CO-2	Perform reliability analysis of the power systems such as generators and transmission lines, using analytical simulation tools.	1, 2	4	3
CO-3	Evaluate reliability indices for distribution systems.	1	1, 2	4
CO-4	Analyze the system modes of failure to enhance the power systems reliability and evaluate reliability worth.		1, 2	3, 4

PO's	**PO-1**	**PO-2**	**PO-3**	**PO-4**
Mapping Level	**3.0**	**2.0**	**3.0**	**2.0**

Prerequisites: Power systems Engineering, Graph Theory

Contents:

I. Basic Concepts

Adequacy and Security, System Analysis, Reliability Cost and Reliability Worth.

4 Hrs.

II. Generating capacity

Basic Probability Methods, generation system model, Loss of load indices, Equivalent forced outage rate, scheduled outages, evaluation methods, load forecast and forced outage rate uncertainty, Loss of Energy indices. Frequency and Duration Methods: generation model, system risk indices. **8 Hrs**.

III. Interconnected Systems

Probability array method in two and three interconnected systems, factors assisting emergency assisting systems. Frequency and Duration approach. **8 Hrs**.

IV. Composite Generation and Transmission Systems

Conditional probability approach, network configurations, state selection, system and load point indices, data requirements for composite system reliability evaluation. **8 Hrs.**

V. Distribution Systems

Basic techniques and radial networks, Additional interruption indices, application to radial system, probability distribution of reliability indices. Plant station availability. Parallel and meshed networks: - basic evaluation techniques, inclusion of bus bar failures, scheduled maintenance, temporary and transient failures, common mode failures etc. **8 Hrs**.

VI. Monte Carlo simulation

Concept, application to generation capacity reliability evaluation, application to composite generation and transmission systems, application to distribution systems. **8 Hrs.**

VII. Evaluation of Reliability worth

Implicit/explicit evaluation of reliability worth, customer interruption cost evaluation, basic approaches and customer damage functions. **8 Hrs.**

Reference Books:

[1] Roy Billington, “Reliability Evaluation of Power systems Reliability”, Springer India, 1996.

[2] R. Billington and A.N. Allen, “Reliability Evaluation of Engineering Systems; Concepts and Techniques” Springer, 1992.

[3] Hammersley J. M., Handscomb D.C, “Monte Carlo Methods”, John Wiley and Sons Inc. NY, 1964.

[4] Roy Billington, “Reliability Assessment of Large Electric Power systems”, Kluwer Academic Press/Springer India, 2008.

18PEPSE313 Programmable Logic Controllers and Applications (4-0-0) 4

Contact Hours: 52

Course Learning Objectives (CLOs):

The automation in the power systems and also in many of the industrial applications has gained lots of importance in the recent times. The Programmable Logic Controllers (PLC) is one of the important resources of automatic process control systems. The complex control strategies can be effectively realized by means of PLCs. The students shall be able to understand the concept of PLC based systems, the general architecture of PLCs and the operation of PLCs. Apart from this the students shall know the different controllers used in PLC applications

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1 to 4)**		
		Substantial Level(3)	**Moderate Level(2)**	**Slight Level(1)**
CO-1	Recite the various aspects programming logic controllers			3
CO-2	Construct the ladder diagrams for different process control applications using PLC		3	
CO-3	Understand the operation of PLC registers, timers and counters		3	
CO-4	Use the different controllers for the PLC applications in process control.			4

PO's	**PO-1**	**PO-2**	**PO-3**	**PO-4**
Mapping Level			**2.5**	**1.0**

Prerequisites: Digital Electronics, Microcontrollers, Control System

Contents:

I. PLC Basics

PLC system, I/O modules and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, devices connected to I/O modules. **8 Hrs.**

II. PLC Programming

Input instructions, outputs, operational procedures, programming examples using contacts and coils, drill press operation. Digital logic gates, programming in the Boolean algebra system, conversion examples. Ladder diagrams for process control: Ladder diagrams and sequence listings, ladder diagram construction and flow chart for spray process system. **8 Hrs.**

III. PLC Registers:

Characteristics of Registers, module addressing, holding registers, input registers, output registers. **8 Hrs.**

IV. PLC Functions

Timer functions and Industrial applications, counters, counter function industrial applications, Arithmetic functions, Number comparison functions, number conversion functions**.** **8 Hrs.**

V. Data handling functions

SKIP, Master control Relay, Jump, Move, FIFO, FAL, ONS, CLR and Sweep functions and their applications. Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two axes and three axis Robots with PLC, Matrix functions. **10 Hrs.**

VI. Analog PLC operation:

Analog modules and systems, Analog signal processing, multi bit data processing, analog output application examples, PID principles, position indicator with PID control, PID modules, PID tuning, PID functions. **10 Hrs.**

Reference Books:

[1] Programmable Logic Controllers – Principle and Applications by John W. Webb and Ronald A. Reiss, Fifth Edition, PHI

[2] Programmable Logic Controllers – Programming Method and Applications by J. R. Hackworth and F.D. Hackworth Jr. – Pearson, 2004.

[3] Introduction to Programmable Logic Controllers- Gary Dunning-Cengage Learning.

[4] Programmable Logic Controllers –W. Bolton-Elsevier publisher

18PEPSL301	Internship in Industry	(0-0-6) 3

2 to 4 weeks

Course Learning Objectives (CLOs):

Internship provides the opportunity for the students to get exposure to the real time systems that include personal training , time and stress management, presentations, marketing, liability and risk management, maintenance and responding to emergencies etc. Further they learn to relate theory and practice. They also learn the significance of adhering to the professional standards in the field**.**

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1, 4)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Know the industrial environment.		**3**	**1**
CO-2	Apply knowledge and skill in the professional career.		**3**	**1**
CO-3	Acquire the ability of report preparation and presentation skills.	**2**		
CO-4	Follow the code of practice in power system related activities.		**4**	

PO's	**PO-1**	**PO-2**	**PO-3**	**PO-4**
Mapping Level	**1.0**	**3.0**	**2.0**	**2.0**

Prerequisites: Knowledge of both theory and practical courses learnt in all the previous Semesters and relevant value added information.

Contents:

[1] The students are expected to undergo industrial training in power system engineering or related domain. They are required to know the functions of Engineers in managing the floor. The skills required in installation, commission, operation, service and maintenance shall be studied and obtained. The organizational behavior and management need to be understood. The above skills obtained need to be documented and presented.

[2] Know the current challenges to power system engineers and try suggesting solutions.

Reference materials/books:

[1] Industrial reference manuals
[2] Data sheets.
[3] Software packages.
[4] Product information brochures.
[5] Interaction with industrial experts.
[6] Internet

18PEPSL302	Project Phase - I	(0-0-15) 9

Duration: 2-4 Weeks

Course Learning Objectives (CLOs):

The students are expected to learn carrying out literature survey to locate the state of the art technology while formulating/defining the project problem in power systems engineering domain. The students are expected to select a topic from an emerging area relevant to electrical power systems and/or other relevant branches/Electrical industry related real time problems and define the problem for the project work. The literature survey, visits, data collection, preliminary design, analysis etc. is to be done in this phase. The same work shall be continued in the next phase in IV semester.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1, 4)**		
		Substantial Level(3)	**Moderate Level(2)**	**Slight Level(1)**
CO-1	Carry out the literature survey to locate the state of the art technology in Power systems Engineering field		**1**	**4**
CO-2	Define/formulate the problem for the project work		**1**	**3**
CO-3	Design, develop, analyze, test, interpret the results, fabricate, simulate, write code, prepare report, etc. relevant to his/her project work		**3**	
CO-4	Summarize the work in to a project report and present	**2**		

PO's	PO-1	PO-2	PO-3	PO-4
Mapping Level	**2.0**	**3.0**	**1.5**	**1.0**

Prerequisites: Knowledge of both theory and practical courses learnt in all the previous semesters and relevant value added information.

Contents:

[1] The students are expected to locate the state of the art technology in power systems engineering domain through proper literature survey and select a topic from an emerging area relevant to electrical power systems engineering and/or other relevant branches and define the problem for the project work. The literature survey, visits, data collection, preliminary design, analysis etc. is to be done in this phase.

[2] Know the current challenges to power systems engineers and try suggesting technical solutions.

Reference materials/books:

[1] Engineering books.

[2] International reputed Journals.

[3] Manuals and data sheets.

[4] Software packages.

[5] Previous project reports.

[6] Product information brochures.

[7] Interaction with academia and industrial experts.

[8] Internet`

IV-Semester M. Tech. (Power Systems Engineering)

18PEPSL400	Project Phase - II	(0-0-20) 22

Course Learning Objectives (CLOs):

The students are expected to find out solutions individually for the power systems related problems preferably. They are expected to carry out the intensive literature survey to locate the state of the art technology in power systems engineering. They must learn to formulate/define/locate real time problem for the project work. They will also learn to design, develop, analyze, test, interpret the results, fabricate, simulate, write code, and convert report in to papers for publication in journals to add value to the existing literature. They are also expected to acquire the skills of summarizing the work in to a project report and present the same.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1, 4)**		
		Substantial Level (3)	**Moderate Level(2)**	**Slight Level (1)**
CO-1	Carry out the literature survey to locate the state of the art technology in power systems engineering.		1	4
CO-2	Define/formulate/locate real time problem for the project work		1	3
CO-3	Design, develop, analyze, test, interpret the results, fabricate, simulate, write code, prepare papers etc.	3		
CO-4	Summarize the work in to a project report and present the same	2		

PO's	**PO-1**	**PO-2**	**PO-3**	**PO-4**
Mapping Level	**2.0**	**3.0**	**2.0**	**1.0**

Prerequisites:

Knowledge of both theory and practical courses learnt in all the previous Semesters and relevant value added information.

Contents:

[1] The students are expected to continue the work with real time power systems operation and control related challenges and providing feasible solutions.

Reference materials/books:

[1] Engineering books.
[2] International reputed Journals.
[3] Manuals and data sheets.
[4] Software packages.
[5] Previous project reports.
[6] Product information brochures.
[7] Interaction with academia, industrial experts
[8] Internet