INSTITUTE VISION

To be a preferred institution in Engineering Education by achieving excellence in teaching and research and to remain as a source of pride for its commitment to holistic development of individual and society.

INSTITUTE MISSION

To continuously strive for the overall development of students, educating them in a state of the art infrastructure, by retaining the best practices, people and inspire them to imbibe real time problem solving skills, leadership qualities, human values and societal commitments, so that they emerge as competent professionals.

DEPARTMENT VISION

To be a centre of excellence in teaching and learning to produce the competent & socially responsible professionals in the domain of Electrical & Electronics Engineering.

DEPARTMENT MISSION

I. To educate students with core knowledge of Electrical and Electronics Engineering to excel in their professional career.

II. To develop problem solving skills, professional skills and ethical values among the students for the betterment of mankind.

III. To prepare technically competent and socially responsible Electrical Engineer to serve the future needs of the society.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

Graduates of the program will be able to

PEO1: Achieve successful professional career in Electrical Engineering and allied disciplines.

PEO2: Pursue higher studies and continuously engage in upgrading the professional skills.

PEO3: Demonstrate professional & ethical values, effective communication skills and teamwork to solve issues related to profession, society and environment.

PROGRAM OUTCOMES (POs):

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs) :

PSO1: Apply knowledge & competencies to analyze & design Electrical & Electronics Circuits, Controls and Power Systems, Machines & Industrial Drives.

PSO2: Use Software/Hardware tools for the design, simulation and analysis of Electrical and Electronics Systems.

Contents of VIII-SEM

1.0 Student Help Desk

Sl. No	Coordination Work	Contact Person	
		Faculty	Instructor
01	Attestations	Dr. B. V. Madiggond	-
02	Exam forms signature, Overall department administration, Counseling/interaction with Parents/Students.		
03	Research Centre Coordinator, Academic Coordinator		
04	Project Coordinator, KSCST Coordinator, Hobby & Mini Project Coordinator	Prof. S. D. Hirekodi	-
05	Mentorship Coordinator, GATE Coaching Coordinator	Prof. H. R. Zinage	-
06	Dept. Association Coordinator	Prof. M. P. Yenagimath	-
07	Website Coordinator, Professional Body (ISTE & IEEE) Coordinator, Alumni Coordinator	Prof. O. B. Heddurshetti	-
08	AICTE/VTU/NIRF Coordinator, Dept. News & Publicity Coordinator, AICTE Activity Coordinator	Prof. A. U. Neshti	-
10	Library Coordinator	Prof. A. U. Neshti	Shri. S. B. Beelur
11	IA & EMS Coordinator	Prof. K. B. Negalur	-
12	Seminar Coordinator, News letter/Technical Magazine Coordinator	Prof. S. G. Huddar	-
13	Dispensary	Dr. Arun G. Bullannavar, Contact No. 9449141549	
Class Teacher			
15	4th Semester	Prof. A. U. Neshti	Shri. S. B. Beelur
16	6th Semester	Prof. O. B. Heddurshetti	Shri. V. M. Mutalik
17	8th Semester	Prof. H. R. Zinage	Shri. R. S. Bardol

2.0 Departmental Resources

Department of Electrical and Electronics Engineering was established in the year 1996 and is housedin a total area of **1339 Sq. Mtrs.**

2.1 Faculty Position

S.N.	Category	No. in position	Average experience
1	Teaching faculty	10	17 Y
2	Technical supporting staff	3	25 Y
3	Helper	2	19 Y

2.2 Major Laboratories

SL. No.	Name of the laboratory	Area in Sq. Mtrs	Amount Invested (Rs)
01	Electronics Lab	71	4,49,488.00
02	Operational Amplifier & Linear Integrated Lab		1,29,776.00
03	Power Electronics Lab	92	7,85,162.00
04	Control Systems Lab		2,14,127.00
05	Power System Simulation Lab	71	17,95,111.00
06	Computer Aided Electrical Drawing Lab		6,50,988.40
07	Microcontroller Lab / Digital Signal Processing Lab	72	5,94,122.00
09	Electrical Machines Lab	200	14,85,725.0
10	Relay & High Voltage Lab	94	11,72,383.00
11	Basic Electrical Engg. Lab	96	42,321.00
	Total	**696**	73,19,203.40

3.0 Faculty Details

S.N.	Faculty Name	Designation	Qualification	Area of specialization	Professional membership	Industry Experience (in years)	Teaching Experience (in years)	Contact Nos.
01	Dr. B. V. Madiggond	HOD/Prof.	Ph. D	Power Electronics	LMISTE, YHAI	-	29	9343454993
02	Prof. V. B. Dhere	Asst. Prof.	M. Tech, (Ph. D)	Electronics & Telecommunication	LMISTE, IMPARC	4	25	9886597573
03	Prof. S. D. Hirekodi	Asst. Prof.	M. Tech.	Power Electronics	LMISTE	1	22	9480849338
04	Prof. H. R. Zinage	Asst. Prof.	M. Tech.	Power System	LMISTE	-	22	9480849335
05	Prof. M. P. Yenagimath	Asst. Prof.	M. Tech (Ph. D)	VLSI & ES	LMISTE	1	16.5	9341449466
06	Prof. O. B. Heddurshetti	Asst. Prof.	M. Tech.	Power Electrics	LMISTE	1	15	9448420509
07	Prof. A. U. Neshti	Asst. Prof.	M. Tech.	Digital Electronics	ISTE	-	14	9538223362
08	Prof. K. B. Neglur	Asst. Prof.	M. Tech.	Industrial Electronics	LMISTE	-	09	9886644507
09	Prof. S. G. Huddar	Asst. Prof.	M. Tech.	Power System Engg.	LMISTE	-	09	9742066852
10	Prof. P. I. Savadatti	Asst. Prof.	M. Tech.	Digital Electronics	-	-	07	9964315436

4.0 Institute Academic Calendar

	S J P N Trust's **Hirasugar Institute of Technology, Nidasoshi.** *Inculcating Values, Promoting Prosperity* Approved by AICTE, New Delhi, Permanently Affiliated to VTU, Belagavi Recognized under 2(f) & 12B of UGC Act, 1956 Accredited at 'A' Grade by NAAC & Programmes Accredited by NBA:CSE & ECE	IQAC File I-11 2022-23 (Odd) Rev: 01

CALENDAR OF EVENTS OF VIII SEM FOR THE ACADEMIC YEAR 2022-23 (Even)

Date	Events
13-02-2023	Commencement of VIII Sem
28-02-2023	World Science Day
16-03-2023	First Internal Assessment for VIII Semester & Feedback –I on Teaching-Learning
20-03-2023	Display& Submission of 1st Internal Assessment Marks to Office
07-04-2023	World Health Day
13-04-2023	Second Internal Assessment for VIII Semester & Feedback –II on Teaching-Learning
17-04-2023	Display& Submission of 2nd Internal Assessment Marks to Office
22-04-2023	World Earth Day
26-04-2023	World Intellectual Property Day
05-05-2023	Project Exhibition
11-05-2023	Third Internal Assessment for VIII Semester
13-05-2023	Last working day for VIII Semester Display of final Internal Assessment Marks
16-05-2023 To 01-06-2023	Theory Exams
05-06-2023 To 13-06-2323	Practical /Internship Viva Voice /Project Viva

February-2023

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

18- Mahashivaratri

March -2023

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

22- Yugadi

April -2023

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

03- Mahaveer Jayanti , 07- Good Friday ,
14- Ambedkar Jayanti

May -2023

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

01-Karmika Dinacharane (Labor day)

25.02.23
Dr. R.R.Maggavi
IQAC Coordinator

25/02
Dr. S. C. Kamate
Principal

5.0 Department Academic Calendar

S J P N Trust's
Hirasugar Institute of Technology, Nidasoshi.
Inculcating Values, Promoting Prosperity
Approved by AICTE, New Delhi, Permanently Affiliated to VTU, Belagavi
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EEE | COE | 2022-23 (Even) | Rev: 00

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGG.
CALENDAR OF EVENTS FOR THE VI & VIII SEMESTER 2022-23 (Even)

Date	Events
13-02-2023	Commencement of VIII Sem
28-02-2023	World Science Day
16-03-2023	First Internal Assessment for VIII Semester & Feedback –I on Teaching -Learning
20-03-2023	Display & Submission of 1st Internal Assessment Marks to Office
20-03-2023	Commencement of VI Sem
07-04-2023	World Health Day
13-04-2023	Second Internal Assessment for VIII Semester & Feedback –II on Teaching -Learning
14-04-2023	Fire Prevention Day
17-04-2023	Display & Submission of 2nd Internal Assessment Marks to Office
20-04-2023 to 22-04-2023	First Internal Assessment for VI Semester & Feedback –I on Teaching -Learning
21-04-2023	*Group Discussion*
22-04-2023	World Earth Day
25-04-2023	Display & Submission of 1st Internal Assessment Marks to Office
26-04-2023	World Intellectual Property Day
01-05-2023 to 07-05-2023	Nutrition Week
05-05-2023	*Guest lecture by resource person from Industry/Alumni*
05-05-2023	Project Exhibition
11-05-2023	Third Internal Assessment for VIII Semester
13-05-2023	Last Working day for VIII Semester Display of final Internal Assessment Marks
19-05-2023	*Box Cricket*
22-05-2023	TECHNOVISION - 23
23-05-2023	HSIT QUEST- 23
24-05-2023	HSIT SAMBRAMA- 23
25-05-2023	Graduation Day for VIII Sem
01-06-2023 to 03-06-2023	Second Internal Assessment for VI Semester &Feedback –II on Teaching-Learning
05-06-2023	World Environmental Day
06-06-2023	Display& Submission of 2nd Internal Assessment Marks to Office
09-06-2023	*Farewell function to final year students*
16-06-2023	*Industrial Visits*
21-06-2023	International Yoga Day
23-06-2023	*Quiz Competition*
30-06-2023	*Story telling Competition*
01-07-2023	*Hobby Project competition for 2nd and 3rd year students.*
03-07-2023 to 05-07-2023	Third Internal Assessment for VI Semester
01-07-2023 to 07-07-2023	Banamahostava Week
07-07-2023 to 08-07-2023	Lab Internal Assessment
10-07-2023	Display of Final Internal Assessment Marks
10-07-2023	Last working day for VI Semester

February-2023

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

18-Mahashivaratri

March-2023

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

22-Yugadi

April-2023

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

03-Mahaveer Jayantti, 07-Good Friday,
14-Ambedkar Jayanti

May-2023

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

01-Karmika Dinacharane (Labor Day)

June-2023

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

29-Bakrid

July-2023

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

29-Moharam

Shri. M. P. Yenagimath
EESSA Coordinator

Dr. B. V. Madiggond
HOD

Dr. S. C. Kamate
Principal

6.0 Scheme of Teaching & Examination

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination 2018 – 19
Outcome Based Education(OBE) and Choice Based Credit System
(CBCS)(Effective from the academic year 2018 – 19)

VIII SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	18EE81	Power System Operation and Control	EEE	3	--	--	03	40	60	100	3
2	PEC	18EE82X	Professional Elective - 4	EEE	3	--	--	03	40	60	100	3
3	Project	18EEP83	Project Work Phase - 2		--	--	2	03	40	60	100	8
4	Seminar	18EES84	Technical Seminar		--	--	2	03	100	--	100	1
5	Internship	18EEI85	Internship	Completed during the vacation/s of VI andVII semesters and /or VII and VIII semesters.)				03	40	60	100	3
			TOTAL		**06**	**--**	**04**	**15**	**260**	**240**	**500**	**18**

Note: PCC: Professional Core, PEC: Professional Elective.

Professional Electives - 4

Course code under 18XX82X	Course Title
18EE821	FACTs and HVDC Transmission
18EE822	Electrical Estimation and Costing
18EE823	**Big Data Analytics in Power Systems**
18EE824	Power System Planning
18EE825	Electrical Power Quality

Project Work

CIE procedure for Project Work Phase - 2:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable.

The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

SEE for Project Work Phase - 2:

(i) Single discipline: Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted at the department.

ii) Interdisciplinary: Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belong to.

Internship: Those, who have not pursued /completed the internship, shall be declared as fail and have to complete during subsequent University examination after satisfying the internship requirements.

AICTE activity Points: In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

Activity points of the students who have earned the prescribed AICTE activity Points shall be sent the University along with the CIE marks of 8th semester.In case of students who have not satisfied the AICTE activity Points at the end of eighth semester, the column under activity Points shall be marked NSAP(Not Satisfied Activity Points).

Subject Title	POWER SYSTEM OPERATION & CONTROL		
Subject Code	18EE81	**CIE Marks**	40
Number of Lecture Hrs / Week	03	**SSE Marks**	60
Total Number of Lecture Hrs	40	**Exam Hours**	03
			CREDITS-3

FACULTY DETAILS:		
Name: Prof. Hemalata R Zinage	**Designation:** Asst. Professor	**Experience:** 22
No. of times course taught:10	**Specialization:** Power system	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electrical &Electronics Engineering	VI	Power system analysis -I
02	Electrical &Electronics Engineering	VII	Power system analysis -II

2.0 Course Objectives

1 To describe various levels of controls in power systems and the vulnerability of the system.
2 To explain components, architecture and configuration of SCADA.
3 To explain basic generator control loops, functions of Automatic generation control, speed governors and mathematical models of Automatic Load Frequency Control
4 To explain automatic generation control, voltage and reactive power control in an interconnected power system.
5 To explain reliability and contingency analysis, state estimation and related issues

3.0 Course Outcomes

Having successfully completed this course, the student will be able to

	Course Outcome	Cognitive Level	POs
C415.1	Describe various levels of controls in power systems, architecture and configuration of SCADA	L3	1,2,3,4,5,8,9,10, 12
C415.2	Develop and analyze mathematical models of Automatic Load Frequency Control.	L3,l4	1,2,3,4,5,8,9,10. 12
C415.3	Develop mathematical model of Automatic Generation Control in Interconnected Power system	L3,L4	1,2,3,4,5,8,9,10, 12
C415.4	Discuss the Control of Voltage , Reactive Power and Voltage collapse	L3,L4	1,2,3,4,5,8,9,10, 12
C415.5	Explain security, contingency analysis, state estimation of power systems	L3,L4	1,2,3,4,5,8,9,10, 12
Total Hours of instruction		**40**	

4.0 Course Content

Module-1

Introduction: Operating States of Power System, Objectives of Control, Key Concepts of Reliable Operation, Preventive and Emergency Controls, Energy Management Centers.

Supervisory Control and Data acquisition (SCADA): Introduction, components, application in Power System, basic functions and advantages. Building blocks of SCADA system, components of RTU, communication subsystem, IED functional block diagram. R2

Classification of SCADA system: Single master–single remote; Single master–multiple RTU; Multiple master–multiple RTUs; and Single master, multiple submaster, multiple remote. R2

Module-2

Automatic Generation Control (AGC): Introduction, Schematic diagram of load frequency and excitation voltage regulators of turbo generators, Load frequency control (Single area case), Turbine speed governing system, Model of speed governing system, Turbine model, Generator load model, Complete block diagram of representation of load frequency control of an isolated power system, Steady state analysis, Control area concept, Proportional plus Integral Controller. T1

Module-3

Automatic Generation Control in Interconnected Power system: Two area load frequency control, Optimal (Two area) load frequency control by state variable, Automatic voltage control, Load frequency control with generation rate constraints (GRCs), Speed governor dead band and its effect on AGC, Digital LF Controllers, Decentralized control. T1

Module-4

Control of Voltage and Reactive Power: Introduction, Generation and absorption of reactive power, Relation between voltage, power and reactive power at a node, Methods of voltage control: i) Injection of reactive power, Shunt capacitors and reactors, Series capacitors, Synchronous compensators, Series injection. ii) Tap changing transformers. Combined use of tap changing transformers and reactive power injection, Booster transformers, Phase shift transformers, Voltage collapse. T3

Module-5

Power System Security: Introduction, Factors affecting power system security, Contingency Analysis, Linear Sensitivity Factors, AC power flow methods, Contingency Selection and Ranking. T2

State estimation of Power Systems: Introduction, Linear Least Square Estimation T2

5.0 Relevance to future subjects

SL No	Semester	Subject	Topics
01	VIII	Project work	SCADA, Automatic Generation Control, Voltage and Reactive Power Control, Power System Reliability and Security

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Model creation for analysis
02	Development of a software applications

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Visit to power plant	Operation of energy control center, SCADA system

8.0 Books Used and Recommended to Students

Text Books
1. Modern Power System Analysis, D. P. Kothari, McGraw Hill, 4 th Edition, 2011
2. Power Generation Operation and Control, Allen J Wood etal, Wiley, 2nd Edition, 2003
3. Electric Power Systems, B M Weedy, B J Cory, Wiley, 4 th Edition, 2012

Reference Books
1. Computer-Aided Power System Analysis, G. L. Kusic, CRC Press, 2nd Edition, 2010
2. Power System SCADA and Smart Grid, Mini S Thom and John D. McDonald, CRC Press, 2015
3. Power System Stability and Control, Kundur, McGraw Hill, 8 th Reprint, 2009
Additional Study material & e-Books
1. Research Papers on Power System Operation and Control published in Journals

9.0 Relevant Websites (Reputed Universities and Others) for Notes/Animation/Videos Recommended

Website and Internet Contents References
1) *nptel.ac.in/courses/108104052*
2) *freevideolectures.com › Electrical Engineering › IIT Kanpur*
3) *nptel.iitg.ernet.in*

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	IEEE Explore	***ieeexplore.ieee.org/xpl/RecentIssue***
2	Journalof Modern *Power Systems* and Clean Energy	***www.springer.com***

11.0 Examination Note

SCHEME OF EVALUATION FOR CIE (40 MARKS)

- Internal Assessment test will be done in the same pattern as that of the main examination.

Internal Assessment : 50 marks scaled down to 30 marks
Assignment marks: 10 marks.

SCHEME OF EXAMINATION: 100 Marks, scaled down to 60 in VTU result sheet.

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

12.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecture	% of Portion
I	1.	**Introduction:** Operating States of Power System, Objectives of Control,	20
	2.	Key Concepts of Reliable Operation Preventive and Emergency Controls, Energy Management Centers	
	3.	**Supervisory Control and Data acquisition (SCADA):** Introduction, components, application in Power System,	
	4.	Basic functions and advantages. Building blocks of SCADA system, components of RTU,	
	5.	Communication subsystem, IED functional block diagram. R2 Single master–multiple RTU;	
	6.	**Classification of SCADA system:** Single master–single remote;	
	7.	Multiple master–multiple RTUs	
	8.	Single master, multiple sub master, multiple remote. R2	

II	9.	**Automatic Generation Control (AGC):** Introduction, Schematic diagram of load frequency	**20**
	10.	Excitation voltage regulators of turbo generators,	
	11.	Load frequency control (Single area case),	
	12.	Turbine speed governing system,	
	13.	Model of speed governing system, Turbine model, Generator load model,	
	14.	Complete block diagram of representation of load frequency control of an isolated power system,	
	15.	Steady state analysis, Control area concept,	
	16.	Proportional plus Integral Controller. T1	
III	17.	**Automatic Generation Control in Interconnected Power system**:	**20**
	18.	Two area load frequency control,	
	19.	Optimal (Two area) load frequency control by state variable,	
	20.	Automatic voltage control,	
	21.	Load frequency control with generation rate constraints (GRCs),	
	22.	Speed governor dead band and its effect on AGC,	
	23.	Digital LF Controllers,	
	24.	Decentralized control. T1	
IV	25.	**Control of Voltage and Reactive Power:** Introduction, Generation Absorption of reactive power, Relation between voltage, power and reactive power at a node,	**20**
	26.	Methods of voltage control: i) Injection of reactive power,	
	27.	Shunt capacitors and reactors, Series capacitors	
	28.	Synchronous compensators, Series injection.	
	29.	ii) Tap changing transformers.	
	30.	Combined use of tap changing transformers and	
	31.	Reactive power injection,	
	32.	Booster transformers, Phase shift transformers, Voltage collapse. T3	
V	33.	**Power System Security:** Introduction,	**20**
	34.	Factors affecting power system security,	
	35.	Contingency Analysis,	
	36.	Linear Sensitivity Factors,	
	37.	AC power flow methods	
	38.	Contingency Selection and Ranking. T2	
	39.	**State estimation of Power Systems:** Introduction,	
	40.	Linear Least Square Estimation T2	

3.0 Assignments

Sl. No.	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1: University Questions on Supervisory Control and Data acquisition &Unit Commitment	Students study the Topics and write the Answers. Get practice to solve university questions.	module 1 of the syllabus	2	Individual Activity.	Book 1, 2 of the reference list. Website of the Reference list
2	Assignment 2: University Questions on Hydro-thermal Scheduling	Students study the Topics and write the Answers. Get practice to solve university questions.	module2 of the syllabus	4	Individual Activity.	Book 2 of the Text book list. Website of the Reference list
3	Assignment3: University Questions onAutomatic Generation Control (continued	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 3 of the syllabus	6	Individual Activity.	Book 2 of the Text book list. Website of the Reference list
4	Assignment 4: university Questions Voltage and Reactive Power Control	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 4of the syllabus	8	Individual Activity.	Book 4 of the Text book list. Website of the Reference list
5	Power System Reliability and Security & State estimation of Power Systems	Students study the Topics and write the Answers. Get practice to solve university questions.	module5of the syllabus	10	Individual Activity.	Book 3 of the Text book list. Website of the Reference list

14.0 QUESTION BANK

MODULE -1 Introduction to Power System Operation and Control

[1] Explain the Operating states of power system.
[2] Discuss the preventive and emergency controls of power system.
[3] Explain the operation of energy management system.
[4] Explain the SCADA system and its components.
[5] What are the common communication channels for SCADA?
[6] Discuss the challenges for implementation of SCADA.

MODULE-2 Automatic Generation control

[1] Why automatic generation & voltage control is required? Explain.
[2] Explain the objectives and functions of Automatic Generation Control (AGC) in a Power System
[3] Explain the complete block diagram representation of load frequency control of an isolated power system.
[4] Explain how mathematical model of speed governing system is developed for automatic generation control

MODULE-3 Automatic Generation Control in interconnected Power System

[1] Explain the steady state analysis of load frequency control of an isolated system & hence draw the characteristic.
[2] Explain the dynamic state analysis of load frequency control of an isolated power system & hence draw the characteristic.
[3] Show that active power generation is proportional to power command ΔP_c.
[4] What is area control error? Explain the advantages of pool operation.

[5] Explain how we can bring frequency deviation will be zero under steady state condition.
[6] With the help of neat block diagram explain the execution of economic dispatch using area control error (ACE) and base load deviation (BLD)
[7] Explain the parallel operation of alternators.
[8] A 100 MVA synchronous generator operates on full load at frequency of 50 Hz. The load is suddenly reduced to 50MW. Due to time lag in governor system, the steam valve begins to close after 04 seconds. Determine the change in frequency that occurs in this time. Given H= 5Kw-sec/KVA of generator capacity.
[9] Explain with the help of block diagram, the automatic load frequency and voltage regulator loops of a synchronous generator.
[10] Describe the function of AVR with a neat block diagram.
[11] With a neat diagram, explain the brushless AVR loop.
[12] Obtain the brushless excitation modeling & explain the static performance of the brush-less AVR Loop.
[13] Two generators are supplying power to a system, their rating is 50 MW & 500 MW respectively, frequency is 50 Hz and each generator is half loaded. The system load increases by 110 MW and as a result the frequency drops to 49.5 Hz. What must be the individual regulation if the two generators should increase their power in proportion to their rating? (Assuming governor free action and constant B is negligible)
[14] Two generating units rated 200MW and 400MW are operating in parallel. The droop characteristics of their governors are 4% and 5% respectively from no load to full load. Assuming that the generators are operating at 50Hz at no load, how would a load of 600MW is shared between them? What will be the system frequency at this load? Assume free governor operation. Repeat the problem if both governors have a droop of 4%.
[15] Two synchronous generators operate in parallel and supply a total load of 200MW. The capacities of the machines are 100MW and 200MW and both have governor droop characteristics of 4% from no load to full load. Calculate the load taken by each machine assuming free governor action.
[16] Two synchronous generators operate in parallel and supply a total load of 400MW. The capacities of the machines are 200MW and 500MW and both have governor droop characteristics of 4% from no load to full load. Calculate the load taken by each machine, assuming free governor action. Also find system frequency at this load.
[17] Two identical 60MW synchronous generators operate in parallel. The governor settings on the machines are such that they have 4% and 3% droops (no load to full load % speed drop).Determine
(a) The load taken by each generator (machine) for a total load of 100MW.
(b) The % adjustment in the no load speed to be made by the speeder motor if the machines are to share the load equally. Assume frequency as 60Hz.
[18] For an isolated single area, consider the following data,
Area capacity, Pr =1000MW
Nominal operating load = P^0_D =500MW
Inertia constant, H= 5Kw-sec/KVA
Regulation = R = 5%
Nominal frequency=f^0 = 50 Hz
Load decreased by 1% for a decrease in frequency by 1%
Find the gain and time constant of power system tube represented with a first order transfer function. Corresponding to a change of load by 50MW, what would be the change in frequency for the system if it is uncontrolled one?
[19] For the single area control system shown in Fig.1, we have following data:
T_p = 10 seconds, T_g= T_t=0, Kp= 100Hz/pu.Mw, D = 3Hz/pu.Mw, ΔP_D = 0.1puMw, K_i = 0.1
Compute the time error caused by a step disturbance of magnitude given above. Prove that the error is reduced by increasing the given K_i. Express the error in seconds and cycle if the system frequency is 50 Hz

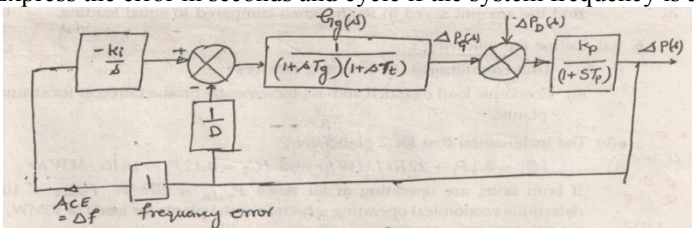

Fig.1

MODULE-4

[5] Describe the various factors affecting the voltage stability and voltage collapse.
[6] What is voltage instability? Explain the phenomenon of voltage collapse with relevant PV and QV diagrams.
[7] What is voltage collapse? Explain with PV and QV characteristics of loads
[8] Explain how the voltage control is achieved by injection of reactive power at nodes
[9] Explain the following methods of the voltage control in a power system:
(i) Injection of capacitive or inductive reactive power.(ii) By tap changing of transformers
[10]. Explain different methods of voltage control.
[11] Describe the control characteristics of an SVC.
[12 Show that the power flow between two nodes is determined by the transmission angle and the flow of reactive power is determined by the scalar voltage difference between the two nodes
[13] A single line diagram for a typical 3 supply points A, B, & C is shown in Fig.1. Determine the reactive power compensation required to inject at point 'M' to reestablish original value when the voltage at 'M' falls by 6 kV (Assume 500 MVA Base and Neglect resistances)

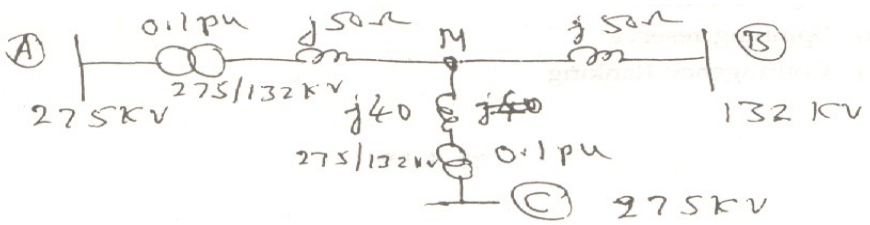

Fig.3

[14] Mention and explain in detail about generators of reactive power and absorbers of reactive power.
[15] In view of reactive power generation and absorption, briefly explain the characteristics of synchronous generator, overhead lines and cables.

MODULE-5

[1] Define system security and explain major functions involved in the system security.
[2] Explain the importance of security assessment in the power system. What are the constraints and how these constraints differ from the normal operating constraints?
[3] Distinguish between the normal operating constraints and security constraints of a power system.
[4] What are the factors which affect the power system security?
[5] What is contingency Analysis? Explain any one method of contingency evaluation
[6] What are credible contingencies? Explain the methods of analyzing such contingencies.
[7] What is Contingency Ranking?
[8] Explain the contingency analysis with the help of flow chart.
[9] Explain the role of sensitivity factors in the contingency analysis.
[10] Explain the contingency analysis using sensitivity factors with the help of flow chart
[11] What are the actions that must be taken for correcting the generation dispatch by sensitivity method?
[12] Explain the detection of network problems.

Prepared & Checked by		
21/02/23	21.2.23	
Prof. Hemalata R Zinage	**HOD**	**Principal**

Subject Title	**BIG DATA ANALYTICS IN POWER SYSTEMS**		
Subject Code	18EE823	**CIE Marks**	40
Number of Lecture Hrs / Week	3:0:0	**SEE Marks**	60
Total Number of Lecture Hrs	40	**Exam Hours**	03
		CREDITS – 04	

FACULTY DETAILS:		
Name: Prof. Mahesh Yenagimath	**Designation:** Asst.Professor	**Experience:** 17 years
No. of times course taught: 02		**Specialization:** VLSI and Embedded System

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electrical and Electronics Engineering	VII	Power System Protection

2.0 Course Objectives

- To define big data and to explain big data application and analytics to power systems.
- To explain the role of big data in smart grid communications and optimization of big data in electric power systems.
- To explain security methods for the infrastructure communication and data mining methods for theft detection in power systems.
- To explain the application of unit commitment method in the control of smart grid.
- To explain protection algorithm for transformer based on data pattern recognition.

3.0 Course Outcomes

The student, after successful completion of the course, will be able to :

	Course Outcome	RBT Leve	Pos
C423.1	Discuss role of big data and machine-learning methods applicable to power systems and in particular to Smart Grid communications.	L_2	PO1, 2,3,4,5,6,8, 9, 10,12
C423.2	Discuss optimization methods which are suitable for big data models in power systems.	L_2	PO1, 2,3,4,5,6,8, 9, 10,12
C423.3	Discuss various cyber security issues, electricity theft detection and mitigation that exist in IoT-enabled future power systems.	L_4	PO1, 2,3,4,5,6,8, 9, 10,12
C423.4	Discuss renewable energy planning concerns associated with planned future power systems that have high renewable penetration.	L_4	PO1, 2,3,4,5,6,8, 9, 10,12
C423.5	Discuss various methods for transformer differential Protection.	L_4	PO1, 2,3,4,5,6,8, 9, 10,12
	Total Hours of instruction	**40**	

4.0 Course Content

Module-1

Introduction: Big Data, Future Power Systems.

Big Data Application and Analytics in a Large - Scale Power System: Introduction, General Applications of Big Data, Algorithms for Processing Big Data, Application of Big Data in Power Systems.

Module-2

Role of Big Data in Smart Grid Communications: Introduction, The Grid Modernization, The Grid interconnection with the Internet of Things, Data Traffic Pattern in a Smart Grid Environment, The Massive Flow of Information in a Smart Scenario, The Volume of Generated Data in a Smart Distribution System: A Case of Study. Big Data Optimization in Electric Power Systems: Introduction, Background, Scientometric Analysis of Big Data, Big Data and Power Systems, Optimization Techniques Used in the Big Data Analysis.

Module-3

Security Methods for Critical Infrastructure Communications: Introduction, Effects of Successful Communication System Threats, General Communication System Operations, Industrial Control Networks and Operations, High-Level Communication System Threats, Cyber Threats and Security. **Data - Mining Methods for Electricity Theft Detection:** Introduction, Transmission and Distribution System Losses, Electricity Theft Methods, Data Mining and Electricity Theft, Issues and Directions in Electricity Theft-Related Data-Mining Research.

Module-4

Unit Commitment Control of Smart Grids: Introduction, Renewable Energy Resources, The Unit Commitment Problem, A Multi-agent Architecture, Illustrative Example.

Module-5

Transformer Differential Protection Algorithm Based on Data Pattern Recognition: Big Data and Power System Protection, Methods for Differential Protection Blocking, Principal Component Analysis, Curvilinear Component Analysis (CCA), PCA Applied to Discriminate Between Inrush and Fault, Currents in Transformers, Application of the CCA as a Base for a Differential Protection System Under Study, Results.

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VIII	Project work	Automation

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Grid Modernization
02	Data - Mining Methods for Electricity Theft Detection

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Tutorial	Optimization Techniques Used in the Big Data Analysis

8.0 Books Used and Recommended to Students

Text Books
1.Big Data Analytics in Future Power Systems,Ahmed F. Zobaa and Trevor J. Bihl, CRC Press,2019.

9.0 Relevant Websites (Reputed Universities and Others) for Notes/Animation/Videos Recommended

Website and Internet Contents References
1) https://www.sciencedirect.com/book/9780128119686/big-data-application-in-power-systems

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	Website
1	Research Gate	https://www.researchgate.net/publication/328192083_Power_systems_big_data_analytics_An_assessment_of_paradigm_shift_barriers_and_prospects
2	Science Direct	https://www.sciencedirect.com/science/article/pii/S2352484717300616

11.0 Examination Note

Scheme of Evaluation for CIE (40 Marks)

- **Internal Assessment: 30 Marks**

Total of Three Internal Assessment tests will be conducted for 50 Marks each. Average of three tests is scaled downed to 30 Marks.

- **Assignment: 10 Marks**

SCHEME OF EXAMINATION: 100 Marks, scaled down to 60 in VTU result sheet.

The question paper will have ten questions.

- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

12.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecture	% of Portion
1	1	Introduction: Big Data	20
	2	Future Power Systems	
	3	Big Data Application and Analytics in a Large - Scale Power System: Introduction	
	4	General Applications of Big Data	
	5	Algorithms for Processing Big Data	
	6	Machine Learning and Deep learning Generalities	
	7	Application of Big Data in Power Systems.	
	8	Big Data problem in power system Modeling	
2	9	Role of Big Data in Smart Grid Communications: Introduction	20
	10	The Grid Modernization, The Grid interconnection with the Internet of Things	
	11	Data Traffic Pattern in a Smart Grid Environment	
	12	The Massive Flow of Information in a Smart Scenario, The Volume of Generated D in a Smart Distribution System: A Case of Study.	
	13	Big Data Optimization in Electric Power Systems: Introduction, Background	
	14	Scientometric Analysis of Big Data	
	15	Big Data and Power Systems	
	16	Optimization Techniques Used in the Big Data Analysis	
3	17	Security Methods for Critical Infrastructure Communications: Introduction	20
	18	Effects of Successful Communication System Threats, General Communication System Operations	
	19	Industrial Control Networks and Operations, High-Level Communication System Threats, Cyber Threats and Security	
	20	Data - Mining Methods for Electricity Theft Detection: Introduction	
	21	Transmission and Distribution System Losses	
	22	Electricity Theft Methods	
	23	Data Mining and Electricity Theft	
	24	Issues and Directions in Electricity Theft-Related Data-Mining Research.	
	25	Unit Commitment Control of Smart Grids: Introduction	20
	26	Renewable Energy Resources	

4	27	Wind Power	
	28	Solar Power	
	29	The Unit Commitment Problem	
	30	A Multi-agent Architecture	
	31	Smart Grid using Multi-Agent Model	
	32	Illustrative Example	
5	33	Transformer Differential Protection Algorithm Based on Data Pattern Recognition: Introduction	20
	34	Big Data and Power System Protection	
	35	Methods for Differential Protection Blocking	
	36	Principal Component Analysis, Curvilinear Component Analysis (CCA)	
	37	PCA Applied to Discriminate Between Inrush and Fault	
	38	Currents in Transformers	
	39	Application of the CCA as a Base for a Differential Protection System Under Study	
	40	Results	

13.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl. No	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1: University Questions on Big Data Application and Analytics in a Large - Scale Power System.	Students discuss role of big data and machine-learning methods applicable to power systems and in particular to Smart Grid communications	Module 1	2	Individual Activity.	Text book no.1
2	Assignment 2: University Questions on role of Big Data in Smart Grid Communications.	Students discuss optimization methods which are suitable for big data models in power systems.	Module 2	4	Individual Activity.	Text book no.1
3	Assignment 3: University Questions on Security Methods for Critical Infrastructure Communications.	Students able to discuss various cyber security issues, electricity theft detection and mitigation that exist in IoT-enabled future power systems	Module 3	6	Individual Activity.	Text book no.1
4	Assignment 4: University Questions on Unit Commitment Control of Smart Grids.	Students able to discuss renewable energy planning concerns associated with planned future power systems that have high renewable penetration.	Module 4	8	Individual Activity.	Text book no.1
5	Assignment 5: University Questions on Transformer Differential Protection Algorithm Based on Data Pattern Recognition	Students able to discuss various methods for transformer differential Protection.	Module 5	10	Individual Activity.	Text book no.1

14.0 QUESTION BANK

Module 1: Big Data Application and Analytics in a Large - Scale Power System

1. Explain the Big Data Application and analytics used in a Large-Scale Power System.
2. Describe the role of Big Data Analytics in Smart Grid Communications.
3. Discuss Data-Mining Methods used for Electricity Theft Detection.
4. Explain the Data-Based Transformer Differential Protection for Power transformer.
5. Discuss General Applications of Big Data.
6. Explain available algorithms used to process and analyze big data.
7. Show how deep learning provides model for analyzing available big data.
8. Explain Convolutional Neural Network (CNN) and Recurrent Neural Network (RNN) in detail.

Module 2: Role of Big Data in Smart Grid Communications

1. Explain Data Traffic Pattern in a Smart Grid Environment.
2. Show the importance of big data in today's power systems, using scientometric technique and social network analysis (SNA.
3. Discuss the concept of Grid Modernization.
4. Explain Computational Method used for Large-scale Unconstrained Optimization.
5. Define following terms:
6. Data preparation b) Data analysis c) Data validation d) Data collaboration

Module 3: Security Methods for Critical Infrastructure Communications

1) Discuss various effects of successful communication system threats.
2) Explain the General taxonomy of communication system threats with neat diagram.
3) Show OSI 7 Layer Model with threats and protections available per layer.
4) Discuss different electricity theft methods in detail.
5) What you meant by Outright Theft.
6) Describe issues and directions in Electricity Theft-Related Data-Mining Research.

Module 4: Unit Commitment Control of Smart Grids

1) Discuss the Unit Commitment Problem with an example.
2) Explain a Multi-agent architecture with neat diagram.
3) What you meant by Agents Profile discuss in detail.
4) Describe the the Decision-Making Method used in Smart Grid.

Module 5: Transformer Differential Protection Algorithm Based on Data Pattern Recognition

1) Describe Big Data and Power System Protection with neat figure.
2) Describe different methods used for differential protection blocking.
3) Discuss in detail the Principal Component Analysis technique.
4) Explain the Curvilinear Component Analysis (CCA) technique in detail.
5) Show Application of the CCA as a Base for a Differential Protection.
6) Show how PCA is applied to discriminate between inrush and fault currents in transformers.

Prepared by	Checked by		
			
Shri. M. P. Yenagimath	**Shri. M. P. Yenagimath**	**HOD**	**Principal**