JAIDEV EDUCATION SOCIETY'S

J D COLLEGE OF ENGINEERING AND MANAGEMENT

KATOL ROAD, NAGPUR

Website: www.jdcoem.ac.in E-mail: info@jdcoem.ac.in

An Autonomous Institute, with NAAC "A" Grade

Department of Electronics and Telecommunication Engineering

"Rectifying Ideas, Amplifying Knowledge"

2021-22 (Odd Sem)

VISION	MISSION
"To be a Department providing high quality & globally competent knowledge of concurrent technologies in the field of Electronics and Telecommunication."	1. To provide quality teaching learning process through well-developed educational environment and dedicated faculties. 2. To produce competent technocrats of high standards satisfying the needs of all stakeholders.

Teaching Plan

Course: B. Tech in Electrical Engineering	**Year/Semester :** 3rd Semester (2nd Year)	
Name of the Teacher : Mr. P. V. Ambade	**Subject Code :** EE3T005	
Subject : Measurement & Instrumentation	**Section :-**	
Periods per Week (each 60 min)	**Lecture**	**3**
	Tutorial	**1**
	Practical	**1**

Course Objective		Course Outcomes	
1	Remembering the fundamental principles of electrical instruments and measurements	1	**Remember** the different types of instruments used in electrical measurements.
2	Classification of various electrical measuring instruments	2	**Understand** the operating principles of various electrical measuring instruments.
3	Make a use of operating principles of various electrical measuring instruments.	3	**Apply** knowledge of variety of instruments available for required parameter and **identify** the appropriate one.
4	To distinguish between variety of measuring instruments available.	4	**Analyze** and **classify** different electrical measuring instruments on basis of type of electrical/ physical quantity to be measured.
5	To utilize various electrical measuring instruments for different measurements.	5	**Evaluate** different electrical measuring instruments
6	Estimate various parameters of electrical measuring instruments.	6	**Test and solve** various problems on electrical measuring instruments

Sr. No	Lec. No	Topic Code	Contents to be Covered	Planned Teaching Dates	Text Books (Page no) Reference Book (Page no)	URL's (NPTEL/OnlineMaterial/PPt/Video)	Applications (R&D/ Industry)	Learning Outcomes	CO mapping
Unit I –Generalized principles of measurements									
1	1	1	Measurement system measurement standards – characteristics - errors in measurement.calibration of meters-significance of IS standards of Instruments.	Day 1	T1 (17-24)	https://www.youtube.com/watch?v=0gKX3ZmT5DU	C1, C2	Student will be able to explain errors in measurement.	CO-1
2	2	2	Classification of meters - operating forces - essentials of indicating instruments - deflecting, damping, controlling torques.	Day 2 to Day 3	T1 (25-39)	https://nptel.ac.in/courses/108/105/108105153/	C1, C2	Student will be able to classify meters.	CO-2
3	3	3	Ammeters and voltmeters - moving coil, moving iron, constructional details and operating, principles shunts and multipliers – extension of range.	Day 4 to Day 5	T1 (78-95)	https://nptel.ac.in/courses/108/105/108105153/	C1, C2	Student will be able to explain the operating principle of moving iron instruments.	CO-2
Unit II – Measurement of resistance									
4	4	4	Classification of resistance.Measure	Day 6	T2 (95-103)	https://www.youtube.com/watch?v=ip6P7-	C2	Student will be able to classify resistances.	CO-2

			ment of medium resistances – ammeter and voltmeter method, substitution method, Wheatstone bridge method.			gT2OE			
5	5	5	Measurement of low resistances – Potentiometer method and Kelvin's double bridge method.	Day 7 to Day 8	T8 (120-134)	https://www.youtube.com/watch?v=hP59aaUr8iY	C2	Student will be able to explain working of Kelvin's double bridge.	CO-2
6	6	6	Measurement of high resistance: Loss of Charge Method, Direct Deflection Method,	Day 9	T1 (550- 554)	https://www.youtube.com/watch?v=ZGEGZc8M54o	C1	Student will be able to understand measurement of high resistance.	CO-2
7	7	7	Price's Guardwire method. Measurement of earth resistance.	Day 10	T2 (125-127)	https://www.youtube.com/watch?v=TYVGndneEXE	C1,C2	Student will be able to understand measurement of earth resistance	CO-5
Unit III – AC Bridges									
8	8	8	Generalized treatment of four-arm AC bridges.Sources and detectors. Maxwell's bridge, Hay's bridge Anderson bridge, Owens Bridge for self inductance measurement	Day 11 to Day 12	T1 (789-796)	https://www.youtube.com/watch?v=I5k66ESHJHM&t=1s	C1, C4	Student will be able to explain the working of Maxwell's bridge.	CO-1; CO-2
9	9	9	Heaviside's bridge for mutual inductance	Day 13	T1 (803-815)	https://www.youtube.com/watch?v=I9Fu0ZTlmqQ	C2,C4	Student will be able to understand measurement of mutual inductance.	CO-2

			measurement						
10	10	10	De Sauty Bridge, Schering bridge for capacitance measurement.	Day 14	T2 (525-532)	https://www.youtube.com/watch?v=6f7bgwkRfSI	C2	Student will be able to explain the working of Schering bridge.	CO-2; CO-4; CO-5
11	11	11	Wien's bridge frequency measurements.Sources of error in bridge measurements and precautions.Screening of bridge components.	Day 15	T2 (568-572)	https://www.youtube.com/watch?v=lRk3vBpH0bs	C2	Student will be able to understand the measurement of frequency	CO-1
Unit IV – Introduction to high voltage and high current measurements									
12	12	12	Measurement of high DC voltages - measurement of high AC voltages - electrostatic voltmeters – sphere gaps - DC Hall effect sensors - high current measurements.	Day 16 to Day 17	T3 (124- 127)	https://www.youtube.com/watch?v=e-kfKuHGfIo	C3	Student will be able to understand the measurement of high DC voltages.	CO-1; CO-2
13	13	13	Study of Phasor Measurement Units (PMU).	Day 18	T3 (135-142)	https://www.youtube.com/watch?v=lVFWHCwI8PU	C2,C3	Student will be able to explain the working of PMU.	CO-6
14	14	14	Current transformers and potential transformers – principle working, ratio and phase angle errors –	Day 19	T4 (159-165)	https://nptel.ac.in/courses/108/105/108105153/	C2, C3	Student will be able to understand the working of current and potential transformers.	CO-3; CO-4

			numerical problems, Clamp on meters						
Unit V – Measurement of Power and Energy									
15	15	15	Principle of Measurement of active, reactive and apparent power single and in polyphasecircuits.	Day 20	T5 (435-446)	https://www.youtube.com/watch?v=0jbvqPPm0z8	C3	Student will be able to know various types of powers in polyphase circuits	CO-1
16	16	16	Measurement of Energy in single and polyphase circuits.	Day 21	T5 (468-474)	https://nptel.ac.in/courses/108/105/108105153/	C3	Student will be able to explain measurement of energy in single phase circuits.	CO-2
17	17	17	Electrodynamometer Wattmeters, Construction, Working, Errors in wattmeter,	Day 22	T5 (525-528)	https://nptel.ac.in/courses/108/105/108105153/	C3	Student will know various errors in wattmeter.	CO-3; CO-3
18	18	18	Single phase Energy meter, Theory and operation , compensation and adjustment.	Day 23	T7 (182-186)	https://www.youtube.com/watch?v=bC-doinU1QM	C3	Student will be able to explain the operation of energy meter	CO-2; CO-4
19	19	19	Testing and calibration of single-phase energy meter by phantom loading	Day 24	T3 (192-196)	https://www.youtube.com/watch?v=InvHHwQnoXk	C3	Student will be able to understand testing and calibration of single phase energy meter	CO-5
Unit VI – Transducers									
20	20	20	Definition and classification - common transducers for measurement of displacement,	Day 25	T1 (974-981)	https://www.youtube.com/watch?v=CzafQ5GWz4s	C4	Student will be able to explain classification of transducers	CO-2; CO-3; CO-4

			velocity, flow, liquid level, force, pressure, strain and temperature						
21	21	21	basic principles and working of LVDT, electromagnetic and ultrasonic flow meters, piezoelectric transducer,	Day 26	T3 (632-638)	https://www.youtube.com/watch?v=6z-PIX3EKGI	C4	Student will be able to understand the working of LVDT.	CO-2; CO-3; CO-4
22	22	22	load cell, strain gauge, RTD, Thermistors, thermocouple, Need for instrumentation system, data acquisition system.	Day 27-28	T1 (1011-1015)	https://www.youtube.com/watch?v=IeOeh1d-U3w	C2,C4	Student will be able to explain operation of RTD.	CO-3; CO-4

*T=Text Book; R= Reference Book; C= Company name; R= Research Paper

Total number of lectures as per syllabus: -28 Total number of lectures as per planned: -28

Content Beyond Syllabus Topic – Planned			
Sr. No.	**Content Beyond Syllabus Topic**	**Date Given**	**Mapped with CO's not covered in TP**
1	Using an Un-Balanced AC Wheatstone Bridge to Measure Capacitance and Inductance	22/11/2021	1,2,3

Text Books / Reference Books:

Code	Title of the Book	Author Name/Designation/ Organization	Publisher	Edition/ Publication Year
T1	A course in Electrical and Electronic Measurements & instrumentation	Sawhney A.K	Dhanpat Rai	22nd Edition
T2	A course in Electrical & Electronic Measurement & Instrumentation	J. B. Gupta	S K Kataria & Sons	3rd Edition
T3	Electronic Instrumentation	Kalsi H. S.	Tata McGraw Hill, New Delhi, 2012	5th Edition
T4	Electrical Measurements & Measuring Instruments	Golding E.W	Wheeler Pub	2nd Edition
T5	Modern Electronics Instrumentation	Cooper W.D.	Prentice Hall of India	4th Edition
T6	Electronic Measurements & Instrumentation	Oliver & Cage	McGraw Hill	Publication year: 2014
T7	Measurements Systems .	E.O Doebelin and D.N Manik, Doebelin	McGraw Hill Education (India) Pvt. Ltd	Sixth edition
T8	Electrical and Electronics Measurements and Instrumentation,	P.Purkait, B.Biswas, S.Das and C. Koley	McGraw Hill Education (India) Pvt. Ltd.,2013	7th Edition

Company/Industry:

Code	Company/Industry Name	Website	Detailed Information
C1	Maxwell Scientific Corporation	http://www.maxwellindia.com/index.html	Maxwell Scientific Corporation develops products using finest grade of raw materials like brass, wire, wooden boxes. The range is widely used in diverse industries due to its efficiency, excellent performance, high durability, strength and corrosion resistance nature.
C2	Nippen Electrical Instruments Company	https://www.nippenco.com/mimcmeter.html	Nippen has been a prominent name in the field of Electrical and Electronic Measuring Instrument for more than the last four decades.. These find applications in Control panels for industry, including Generating Sets, and promintnt users are Electricity utilities , products being sold primarily through Electrical equipment Distributors. Our Analogue and Digital panel meters, Insulation / Earth testers, Current transformers and Shunts have been in use for many years. A newer generation of micro controller based products, includes Multifunction meters, Energy meters, Power Factor Controllers, Maximum Demand Meters / controllers , and transducers to complement the range. Quality, Reliability and

			Durability of our products are the key characteristics that have made Nippen an undisputable leader in the industry.
C3	Schneider Electric	https://www.se.com/in/en/	Schneider's purpose is to empower all to make the most of our energy and resources, bridging progress and sustainability for all. At Schneider, we call this Life Is On. We believe access to energy and digital is a basic human right. Our generation is facing a tectonic shift in energy transition and industrial revolution catalysed by accelerated digitisation in a more electric world. Electricity is the most efficient and best vector for decarbonisation; combined with a circular economy approach, we will achieve a climate-positive impact as part of the United Nations Sustainable Development Goals.
C4	Hi Tech Transducers & Devices	https://hitechtransducers.com/index.html	In today's High Tech Industrial world, process industries call for highly precise monitoring devices which have direct impact on plant operations and on the organizations balance sheet as a whole. Keeping in mind the critical need of the precision monitoring equipement Mr. D.V.Kulkarni, founder of the company decided to cater the industrial requirement.

Research Paper:

Code	Title of the Paper	First Author Name	Journal/Conference Name	DOI no.	Issue/Volume/Page no/Year
P1	A new topology for a current-mode wheatstone bridge	Y.H. Ghallab	IEEE Transactions on Circuits and Systems II: Express Briefs	10.1109/TCSII.2005.854589	16 Jan 2016
P2	Modified Maxwell-Wien bridge with auto source balance	Ding Cheng	2008 Conference on Precision Electromagnetic Measurements Digest	10.1109/CPEM.2008.4574906	8-13 June 2008
P3	IOT Based Smart Energy Meter for Efficient Energy Utilization in Smart Grid	Bibek Kanti Barman	2018 2nd International Conference on Power, Energy and Environment: Towards Smart Technology (ICEPE)	10.1109/EPETSG.2018.8658501	1-2 June 2018
P4	A Novel TDM-Based High-Precision Wattmeter	Ljubisa Jovanuvic	IEEE Transactions on Instrumentation and Measurement	10.1109/TIM.2017.2653458	2 February 2017
P5	Highly Efficient Piezoelectric Micromachined Ultrasound Transducer (PMUT) for Underwater Sensor Networks	Sina Sadeghpour	2019 20th International Conference on Solid-State Sensors, Actuators and Microsystems & Eurosensors XXXIII (TRANSDUCERS &	10.1109/TRANSDUCERS.2019.8808204	23 – 27 June 2019

			EUROSENSORS XXXIII)		

Mr. P. V. Ambade
Subject Teacher

Mr. A. V. Joshi
Academic Incharge

Dr. S. R. Vaishnav
HOD (EE)

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Department of Electrical Engineering

"Rectifying Ideas, Amplifying Knowledge"

2021-22 (Even Sem)

VISION	MISSION
"To develop competent and committed Electrical Engineers to serve the society"	1. To impart quality education in the field of Electrical Engineering. 2. To be excellent learning centre through research and industry interaction.

Teaching Plan

Course: B. Tech in Electrical Engineering	**Year/Semester :**4th Semester (2nd Year)	
Name of the Teacher : Mr. P. V. Ambade	**Subject Code :EE4T003**	
Subject : Power Station Practice	**Section :-**	
Periods per Week (each 60 min)	**Lecture**	**3**
	Tutorial	**1**
	Practical	**1**

Course Objective	Course Outcomes
1 Rememberfundamentalprinciplesofpowerplantsystem 2 Understandvariouspowerplantanditspractices 3 ToapplyEconomicOperation ofPowerSystems. 4 Toanalyze EconomicOperationofPowerSystems 5 Toutilizeconceptofpowerplantoperationsanddemandalsoevaluationofsame. 6 Designparametersofbasicsofpowerplantoperationanditseconomy.	1 Rememberthebasicoperationsofvariouspower plants 2 Understandandinterpretthe requirementsandbasicsofpowerplantinstallationand siteselection 3 ApplyknowledgetoEconomicOperationofPowerSystemsandtheknowledgerelatedwithitsneed 4 Analyzevariouselectricpowerplantsoperationsanddistinguishbetween properties. 5 Evaluatethermal,hydro, nuclear, gaspowerplantalsoabletoExplainitsfundamentals. 6 DesignEconomicOperationofPowerSystemsandalsoabletogivesolutionsimplementationofpower plant on its basics.

Sr. No	Lec. No	Topic Code	Contents to be Covered	Planned Teaching Dates	Text Books (Page no) Reference Book (Page no)	URL's (NPTEL/OnlineMaterial/PPt/Video)	Applications (R&D/ Industry)	Learning Outcomes	CO mapping
Unit I –Introduction									
1	1	1	Electric energy demand and growth in India, electric energy sources. Thermal Power Plant: Siteselection, general layout and operation of plant, detailed description and use of different parts.	Day 1	T1 (17-24)	https://www.youtube.com/watch?v=0gKX3ZmT5DU	C1, C2	Student will be able to explain basics of thermal power plant.	CO-1
2	2	2	HydroElectricPlants:Classifications,locationandsiteselection,detaileddescriptionofvariouscomponents, general layout and operation of Plants	Day 2 to Day 3	T1 (25-39)	https://nptel.ac.in/courses/108/105/108105153/	C1, C2	Student will be able to classify meters.	CO-2
3	3	3	brief description of impulse, reaction, Kaplan andFrancisturbines, advantages&disadvantages,hydro-potential inIndia	Day 4 to Day 5	T1 (78-95)	https://nptel.ac.in/courses/108/105/108105153/	C1, C2	Student will be able to explain the operating principle of moving iron instruments.	CO-2
Unit II – Nuclear Power Plant									
4	4	4	Location, site selection, general layout and	Day 6	T2 (95-103)	https://www.youtube.com/watch?v=ip6P7-gT2OE	C2	Student will be able to classify resistances.	CO-2

			operation of plant. Brief description of different types ofreactors Moderator material,						
5	5	5	fissile materials, control of nuclear reactors, disposal of nuclear wastematerial,shielding.	Day 7 to Day 8	T4 (120-134)	https://www.youtube.com/watch?v=hP59aaUr8iY	C2	Student will be able to explain working of Kelvin's double bridge.	CO-2
6	6	6	GasTurbinePlant:Operationalprinciple ofgasturbineplant& itsefficiency, fuels, open and closed-cycle plants, regeneration, inter-cooling and reheating, role and applications.	Day 9	T1 (550- 554)	https://www.youtube.com/watch?v=ZGEGZc8M54o	C1	Student will be able to understand measurement of high resistance.	CO-2
7	7	7	DieselPlants:Dieselplantlayout,components&theirfunctions,itsperformance,roleandapplications	Day 10	T2 (125-127)	https://www.youtube.com/watch?v=TYVGndneEXE	C1,C2	Student will be able to understand measurement of earth resistance	CO-5
Unit III – Sub-stationsLayout									
8	8	8	Types of substations, bus-bar arrangements, typical layout of substation. Power Plant Economics andTariffs: Load curve, load	Day 11 to Day 12	T1 (789-796)	https://www.youtube.com/watch?v=I5k66ESHJHM&t=1s	C1, C4	Student will be able to explain the working of Maxwell's bridge.	CO-1; CO-2

			duration curve, different factors related to plants and consumers, Cost ofelectrical energy, depreciation, generation cost,						
9	9	9	Effect of Load factor on unit cost. Fixed and operatingcost of different plants,	Day 13	T1 (803-815)	https://www.youtube.com/watch?v=I9Fu0ZTlmqQ	C2,C4	Student will be able to understand measurement of mutual inductance.	CO-2
10	10	10	role of load diversity in power system economy. Objectives and forms ofTariff;	Day 14	T2 (525-532)	https://www.youtube.com/watch?v=6f7bgwkRfSI	C2	Student will be able to explain the working of Schering bridge.	CO-2; CO-4; CO-5
11	11	11	Causes and effects of low power factor, advantages of power factor improvement, differentmethodsforpowerfactorimprovements	Day 15	T2 (568-572)	https://www.youtube.com/watch?v=lRk3vBpH0bs	C2	Student will be able to understand the measurement of frequency	CO-1
Unit IV – EconomicOperationof PowerSystems									
12	12	12	Characteristics of steam and hydro-plants, Constraints in operation,	Day 16 to Day 17	T3 (124- 127)	https://www.youtube.com/watch?v=e-kfKuHGfIo	C3	Student will be able to understand the measurement of high DC voltages.	CO-1; CO-2
13	13	13	Economic load scheduling ofthermalplantsNeglectingandconsidering transmissionLosses	Day 18	T3 (135-142)	https://www.youtube.com/watch?v=lVFWHCwI8PU	C2,C3	Student will be able to explain the working of PMU.	CO-6

			,						
14	14	14	Penalty factor, losscoefficients,Incrementaltransmission loss. Hydrothermal Scheduling	Day 19	T4 (159-165)	https://nptel.ac.in/courses/108/105/108105153/	C2, C3	Student will be able to understand the working of current and potential transformers.	CO-3; CO-4
Unit V –NonConventionalEnergySources									
15	15	15	Power Crisis, future energy demand, role of Private sectors in energy management	Day 20	T3 (435-446)	https://www.youtube.com/watch?v=0jbvqPPm0z8	C3	Student will be able to know various types of powers in polyphase circuits	CO-1
16	16	16	Concepts &principals of MHD generation,	Day 21-23	T4 (468-474)	https://nptel.a/c.in/courses/108/105/108105153/	C3	Student will be able to explain measurement of energy in single phase circuits.	CO-2
17	17	17	Solar power plant, Wind Energy,	Day 24-26	T4 (525-528)	https://nptel.ac.in/courses/108/105/108105153/	C3	Student will know various errors in wattmeter.	CO-3; CO-3
18	18	18	Geothermal Energy	Day 27	T2 (182-186)	https://www.youtube.com/watch?v=bC-doinU1QM	C3	Student will be able to explain the operation of energy meter	CO-2; CO-4
19	19	19	Tidal energy,OceanThermal Energy	Day 28	T3 (192-196)	https://www.youtube.com/watch?v=InvHHwQnoXk	C3	Student will be able to understand testing and calibration of single phase energy meter	CO-5

*T=Text Book; R= Reference Book; C= Company name; R= Research Paper

Total number of lectures as per syllabus: -28 Total number of lectures as per planned: -28

Assignment Plan

Assignment No.	Topic	Given Date	Submission Date	Mapped With CO
1	Hydroelectric Power Plant and Gas Turbine Power Plant	29/3/2022	11/4/2022	CO1, CO2, CO3, CO4
2	Non- conventional energy sources	24/4/2022	7/5/2022	CO1, CO3, CO5, CO6

Content Beyond Syllabus Topic – Planned

Sr. No.	Content Beyond Syllabus Topic	Date Given	Mapped with CO's not covered in TP
1	Dynamic Stability Analysis of Wind Turbines underDifferentControl Strategies	05/05/2022	CO2, CO4, CO5, CO6

Text Books / Reference Books:

Code	Title of the Book	Author Name/Designation/ Organization	Publisher	Edition/ Publication Year
T1	GenerationofElectricalEnergy	B.R.Gupta	DhanpatRai	22nd Edition
T2	AtextbookonPowerSystemEngg	Soni,Gupta&Bhatnagar,	DhanpatRai&Co	3rd Edition
T3	OperationandcontrolofPowerSystem	P.S.R.Murthy	BSPublications	5th Edition
T4	ElementsofPowerSystemAnalysis	W.D.Stevenson	McGrawHill	2nd Edition

Company/Industry:

Code	Company/Industry Name	Website	Detailed Information
C1	Maxwell Scientific Corporation	http://www.maxwellindia.com/index.html	Maxwell Scientific Corporation develops products using finest grade of raw materials like brass, wire, wooden boxes. The range is widely used in diverse industries due to its efficiency, excellent performance, high durability, strength and corrosion resistance nature.
C2	Nippen Electrical Instruments Company	https://www.nippenco.com/mimcmeter.html	Nippen has been a prominent name in the field of Electrical and Electronic Measuring Instrument for more than the last four decades.. These find applications in Control panels for industry, including Generating Sets, and promintnt users are Electricity utilities , products being sold primarily through Electrical equipment Distributors. Our Analogue and Digital panel meters, Insulation / Earth testers,

			Current transformers and Shunts have been in use for many years. A newer generation of micro controller based products, includes Multifunction meters, Energy meters, Power Factor Controllers, Maximum Demand Meters / controllers , and transducers to complement the range. Quality, Reliability and Durability of our products are the key characteristics that have made Nippen an undisputable leader in the industry.
C3	Schneider Electric	https://www.se.com/in/en/	Schneider's purpose is to empower all to make the most of our energy and resources, bridging progress and sustainability for all. At Schneider, we call this Life Is On. We believe access to energy and digital is a basic human right. Our generation is facing a tectonic shift in energy transition and industrial revolution catalysed by accelerated digitisation in a more electric world. Electricity is the most efficient and best vector for decarbonisation; combined with a circular economy approach, we will achieve a climate-positive impact as part of the United Nations Sustainable Development Goals.
C4	Hi Tech Transducers & Devices	https://hitechtransducers.com/index.html	In today's High Tech Industrial world, process industries call for highly precise monitoring devices which have direct impact on plant operations and on the organizations balance sheet as a whole. Keeping in mind the critical need of the precision monitoring equipement Mr. D.V.Kulkarni, founder of the company decided to cater the industrial requirement.

Research Paper:

Code	Title of the Paper	First Author Name	Journal/Conference Name	DOI no.	Issue/Volume/Page no/Year
P1	Cooperative DMPC-Based Load Frequency Control of Solar Thermal Power Plant	Y.H. Ghallab	IEEE Transactions on Circuits and Systems II: Express Briefs	10.1109/TCSII.2005.854589	16 Jan 2016
P2	Voltage control by small hydro power plant integrated into a virtual power plant	Ding Cheng	2008 Conference on Power system Digest	10.1109/CPEM.2008.4574906	8-13 June 2008
P3	Analysis on Spent Fuel Pool Monitoring System in Nuclear power plant after Fukushima Accident	Bibek Kanti Barman	2018 2nd International Conference on Power, Energy and Environment: Towards Smart Technology (ICEPE)	10.1109/EPETSG.2018.8658501	1-2 June 2018

P4	Simulation Model of Autonomous Solar power plant with Dual-Axis Solar Tracker	Ljubisa Jovanuvic	IEEE Transactions on Instrumentation and Measurement	10.1109/TIM.2017.2653458	2 February 2017
P5	Index for allocation of tidal current power plant for reactive margin improvement	Sina Sadeghpour	2019 20th International Conference on Power Systems, Solid-State Sensors, Actuators and Microsystems & Eurosensors XXXIII (TRANSDUCERS & EUROSENSORS XXXIII)	10.1109/TRANSDUCERS.2019.8808204	23 – 27 June 2019

Subject Teacher **Academic InchargeHOD (EE)**

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An Autonomous Institute, with NAAC "A" Grade
Department Of Electrical Engineering
"Igniting minds to illuminate the world"
2021-22 (Odd Sem)

VISION	MISSION
"To develop competent and committed Electrical Engineers to serve the society"	1. To impart quality education in the field of Electrical Engineering. 2. To be excellent learning center through research and industry interaction.

Teaching Plan

Course	**:** B. Tech in Electrical Engineering	**Year/Semester**	**:** 5th Semester (3rd Year)
Name of the Teacher	**:** Prof. Ashutosh V.Joshi	**Subject Code**	**:** EE5T003
Subject	**:** Power System-II	**Section**	**:**A
Periods per Week (each 60 min)		**Lecture**	**3**
		Tutorial	**-**
		Practical	**2**

Course Objective	Course Outcomes
1. To understand the the different parameters of power system operation. 2. To understand the different parameters of power system control. 3. To study different issues related to power systems. 4. After learning, students will be able to analyze different solution methods related to power system 5. Understand amongst the different analytical & numerical methods for power flow solutions 6. Understand different problems related to cost load flow, fault, reactive power and Stability constraints in the power systems.	1. **Define** the different parameters of power system operation. 2. **Illustrate** the different parameters of power system operation and control. 3.To **identify** the different issues related to power systems 4. **Analyze** the different solution methods related to power system .. 5. **Choose** amongst the different analytical & numerical methods for power flow solutions. 6. **Solve** the different problems related to cost load flow, fault, reactive power and Stability constraints in the power systems.

Sr. No	Lec. No	Topic Code	Contents to be Covered	Planned Teaching Dates	Text Books (Page no) Reference Book (Page no)	URL's (NPTEL/OnlineMaterial/PPt /Video)	Applications (R&D/ Industry)	Learning Outcomes	CO mapping
UNIT-I ECONOMIC OPERATIONS OF POWER SYSTEMS									
1	1	1.02	Economic Operation of Power Systems:	L1	T1 (Pg:1)	**Video:** https://www.digimat.in/nptel/courses/video/108107114/L01.html (IIT, Roorkee), Time: 5:10 min to 25:13 min **Notes:**https://nptel.ac.in/courses/112103019/1 (IIT, Guwahati)	--	To study different parameters of power system operation.	CO1
	2	1.03	Distribution of loads between units within a plant	L2	T1 (Pg:3)	**Ppt:** Drawing, Slide no. 81-82	--	To study Distribution of loads between units within a plant	CO1
	3	1.04	Economic division of load between units in a plant	L3	T1 (Pg:7)	**Notes:**https://nptel.ac.in/courses/112103019/1	--	To study Economic division of load between units in a plant	CO1
	4	1.05	transmission loss as a function of plant generation,	L4	T1 (Pg:9)	**Notes:**https://nptel.ac.in/courses/112103019/1 Notes:https://nptel.ac.in/courses/112103019/5	--	To study different parameters of power control	CO2
	5	1.06	Calculation of loss co-efficient	L5	T1 (Pg:12)	**Notes:**https://nptel.ac.in/courses/112103019/11 Notes:https://nptel.ac.in/courses/112103019/13	--	To study different parameters in calculation of loss co-efficient	CO2
Unit-II LOAD FLOW STUDIES									
2	6	2.01	Distribution of load between plants,	L6	R1 (Pg:135)	**Notes:**https://nptel.ac.in/courses/112103019/1	--	To study different parameters of power system operation	CO3
	7	2.02	Introduction to unit commitment,	L7	R1 (Pg:135)	Notes:https://nptel.ac.in/courses/112103019/3	--	To study different parameters of power system control	
	8	2.03	Numerical examples	L8	R1 (Pg:138)	**Notes:**https://nptel.ac.in/courses/112103019/1 Notes:https://nptel.ac.in/courses/112103019/3	--		CO1,CO2
	9	2.04	Load Flow Studies:	L9	R1 (Pg:138)	**Notes:**https://nptel.ac.in/courses/112103019/9 Notes:https://nptel.ac.in/cours	--	To study different parameters of Load Flow Studies	

						es/112103019/3			
	10	2.05	Network model formulation	L10	R1 (Pg:142)	**Notes:**https://nptel.ac.in/courses/112103019/1 Notes:https://nptel.ac.in/courses/112103019/3	--	To study different parameters of Load Flow Studies	CO1
	11	2.06	Applications of iterative techniques like Gauss-Siedal method, and Newton-Rap son method, etc.	L11	R1 (Pg:144)	**Notes:**https://nptel.ac.in/courses/112103019/10 Notes:https://nptel.ac.in/courses/112103019/3	--	To study different parameters of Load Flow Studies	CO1
	12	2.07	Applications of iterative techniques like Gauss-Siedal method, and Newton-Rap son method, etc.	L12	R1 (Pg:145)	**Notes:**https://nptel.ac.in/courses/112103019/1 Notes:https://nptel.ac.in/courses/112103019/3	--	To study different parameters of Load Flow Studies	CO1
	13	2.08	Numerical	L13	R1 (Pg:179)	**Notes:**https://nptel.ac.in/courses/112103019/1 Notes:https://nptel.ac.in/courses/112103019/3	--	To study different parameters of power system operation and control	CO3,4,5,6
	14	2.09	Active Power Control Basic generator control,	L14	R1 (Pg:197)	**Notes:**https://nptel.ac.in/courses/112103019/1 Notes:https://nptel.ac.in/courses/112103019/3	--	To study different parameters of Active Power Control Basic generator control	CO2
	15	2.10	Load frequency control,Load, prime mover and governor model, Numerical examples	L15	R1 (Pg:205)	**Notes:**https://nptel.ac.in/courses/112103019/1 Notes:https://nptel.ac.in/courses/112103019/3	--	To study different parameters of Load frequency control	CO2
Unit-III SYMMETRICAL FAULT ANALYSIS									
3	16	3.01	Symmetrical Components transformation analysis	L16	T1 (Pg:267)	https://nptel.ac.in/courses/112103019/1 https://nptel.ac.in/courses/113103019/1 https://nptel.ac.in/courses/112103019/1 https://nptel.ac.in/courses/1122103019/1 https://nptel.ac.in/courses/112103019/1	--	To study the Symmetrical Components transformation analysis	CO1
	17	3.02	Symmetrical Components transformation analysis	L17	T1 (Pg:267)		--	To study the Symmetrical Components transformation analysis	CO1
	18	3.03	Numerical examples	L18	T1 (Pg:270)		--	To study the Symmetrical Components transformation analysis	CO3,4,5,6

	19	3.04	Numerical examples	L19	T1 (Pg:277)		--	To study the Symmetrical Components transformation analysis	CO2
	20	3.05	Analysis of transformer	L19	T1 (Pg:280)		--	To study the Symmetrical Components tanalysis of transformer	CO2
	21	3.06	Analysis of transmission line	L20			--	To study the Symmetrical Components tanalysis of transmission line	CO1
	22	3.07	Analysis of Synchronous machines	L20			--	To study the Symmetrical Components tanalysis of Synchronous machines	CO1
	23	3.08	Sequence components of network	L20			--	To study Sequence components of network	CO1
	24	3.09	Sequence components of network	L21			--	To study Sequence components of network	CO2
	25	3.10	Numerical examples	L22			--	---	CO2,3,4,5
Unit-IV UNSYMMETRICAL FAULT ANALYSIS									
4	26	4.01	Fault analysis and evaluation of faults on loaded unloaded synchronous generator,	L23	T1 (Pg:289)	https://nptel.ac.in/courses/112103015/1		To understand diff. methods of fault analysis	CO1
	27	4.02	Fault analysis and evaluation of faults on loaded unloaded synchronous generator,	L24	T1 (Pg:289)	https://nptel.ac.in/courses/112103015/1		To understand diff. methods of fault analysis	CO1
	28	4.03	Selection of circuit breaker	L25	T1 (Pg:290)	https://nptel.ac.in/courses/112103019/1		To understand diff. methods of fault stability study	CO1
	29	4.04	asymmetrical fault evaluation of a) Line to ground fault	L26	T1 (Pg:290)	https://nptel.ac.in/courses/112103019/1		To understand diff. methods of fault analysis and stability study	CO2

	30	4.05	asymmetrical faultevaluation of a) Line to ground fault	L27	T1 (Pg:290)	https://nptel.ac.in/courses/112103019/1		To understand diff. methods of fault analysis and stability study	CO2
	31	4.06	b) Line to line c) Double line to ground d) single & double conductor open faults,	L28	T1 (Pg:293)	https://nptel.ac.in/courses/112103019/1	--	To understand diff. methods of fault analysis and stability study	CO1
	32	4.07	b) Line to line c) Double line to ground d) single & double conductor open faults,	L29	T1 (Pg:293)	https://nptel.ac.in/courses/112103019/1	--	To understand diff. methods of fault analysis and stability study	CO1
	33	4.08	Numerical examples	L30	T1 (Pg:290)	https://nptel.ac.in/courses/112103019/1	--	To understand diff. methods of fault analysis and stability study	CO2,3,4,5
	34	4.09	Numerical examples	L30	T1 (Pg:290)	https://nptel.ac.in/courses/112103019/1	--	To understand diff. methods of fault analysis and stability study	CO2,3,4,5
	35	4.10	Numerical examples	L30	T1 (Pg:290)	https://nptel.ac.in/courses/112103019/1	--	To understand diff. methods of fault analysis and stability study	CO2,3,4,5
Unit-V STABILITY									
5	36	5.01	Dynamics of a synchronous machine	L31	T1 (Pg:297)	**Video:** https://www.digimat.in/nptel/courses/video/108107114/L01.html (IIT, Roorkee), Time: 5:10 min to 25:13 min **Notes:**https://nptel.ac.in/courses/112103019/1 (IIT, Guwahati) https://nptel.ac.in/courses/112103019/1 https://nptel.ac.in/courses/112103019/1	--	To understand Dynamics of a synchronous machine	CO2
	37	5.02	Power angle equation	L32	T1 (Pg:299)		--	To understand stability constraints in power systems	CO1
	38	5.03	Steady state stability,	L33	T1 (Pg:305)		--	To understand stability constraints in power systems	CO1
	39	5.04	Equal area criterion	L34	T1 (Pg:300)		--	To understand stability constraints in power systems	CO2
	40	5.05	Numerical solution of swing equation	L35	T1 (Pg:329)		--	To understand stability constraints in power systems	CO1
	41	5.06	Factors affecting transient stability	L36	T1 (Pg:333)		--	To understand Factors affecting transient stability	CO1

	42	5.07	Critical clearance angle	L36	T1 (Pg:348)		--		CO2
	43	5.08	Numerical	L37	T1 (Pg:353)		--	To understand stability constraints in power systems	CO2,3,4,5
	44	5.09	Numerical	L37	T1 (Pg:358)		--		CO2,3,4,5
Unit-VI LOAD DISPATCH CENTER FUNCTIONS									
6	45	6.01	Load dispatch center functions,	L38	T1 (Pg:69)	https://nptel.ac.in/courses/112103019/1	--	To understand Load dispatch center functions	CO1
	46	6.02	Contingency analysis	L38	T1 (Pg:87)		--	To understand Contingency analysis in power systems	CO2
	47	6.03	preventive, emergency and restorative Control	L39	T1 (Pg:91)		--	To understand control strategies in power systems	CO1
	48	6.04	power quality:	L39	T1 (Pg:103)		--	To understand basics of power quality	CO1
	49	6.05	Power quality ,def., causes, affects, slandered and mitigation methods	L40	T1 (Pg:132)		--	To understand basics of power quality ,def., causes, affects, slandered and mitigation methods	CO1
Continue…….									

*T=Text Book; R= Reference Book; C= Company name; R= Research Paper

Total number of lectures as per syllabus: - 40 Total number of lectures as per planned: - 48

Tutorial Plan

Week	Topic	No. Of Problems	Mapped With CO
1	Numericals on Economic operation of power systems.	04	II
2	Numericals on Load flow studies.	02	III
3	Numericals on Symmetrical fault analysis.	04	IV
4	Numericals on unsymmetrical fault analysis.	03	V

5	Numericals on Stability.	03	V
6	Numericals on load dispatch.	01	VI

Assignment Plan

Assignment No.	Topic	Given Date	Submission Date	Mapped With CO
1	Economic operation of power systems	16/8/21	22/8/21	I, II
2	Symmetrical and unsymmetrical fault analysis	16/10/21	22/10/21	III, IV

Content Beyond Syllabus Topic – Planned

Sr. No.	Content Beyond Syllabus Topic	Date Given	Mapped with CO's
1	Static Synchronous Series Compensator (SSSC)	22/10/21	I, II, III, IV, V, VI

Text Books / Reference Books:

Code	Title of the Book	Author Name/Designation/ Organization	Publisher	Edition/ Publication Year
T1	Power System Analysis.	Stevension .W. D–	Tata Mcgraw Hill	10th Edition, 2011
T2	Power System Analysis. (Tata Mcgraw Hill)	Ashfaq Hussian -	Tata Mcgraw Hill	3rd Edition, 2011
T3	Modern Power System Analysis.(Tata Mcgraw Hill)	Nagrath & Kothari	Tata Mcgraw Hill	Revised, 2014

Company/Industry:

Code	Company/Industry Name	Website	Detailed Information
C1	**ABB India**	https://www.new.abb.com/	This company is engaged in the production and supply of Drives,Low voltage Products, relays,C.Bs and other power system equipments and systems,PLC, Automation ,Motors Generators etc.

C2	**Siemens**	https://www.siemens.com/	This company is considered to be the best leading manufacturer and supplier of cost efficient ,safe and sustainable electrical infrastructure. It also supplies other devices like Electrical products involving Transformers ,motors, relays,C.Bs and other power system equipments etc.

Research Paper:

Code	Title of the Paper	First Author Name	Journal/Conference Name	DOI no.	Issue/Volume /Page no/Year
P1	A Practical Distributed Finite-Time Control Scheme for Power System Transient Stability	Ziqiang Wang ; Jie Wang	IEEE Transactions on Power Systems	DOI 3320 - 3331	Publication Year: 2020, Page(s):
P2	A Linear Programming Approximation of Distributionally Robust Chance-Constrained Dispatch With Wasserstein Distance	Anping Zhou ; Ming Yang ; Mingqiang Wang ; Yuming Zhang	IEEE Transactions on Power Systems	3366 - 3377	Publication Year: 2020, Page(s): 3366 - 3377

Prof. Ashutosh Joshi
Subject Teacher

Prof. Ashutosh Joshi
Academic Incharge

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Department of Electrical Engg

2021-22 (VI Sem)

VISION	MISSION
To develop competent and committed Electrical Engineers to serve the society"	1. To impart quality education in the field of Electrical Engineering. 2. To be excellent learning center through research and industry interaction.

Teaching Plan

Course : B. Tech in Electrical Engg		**Year/Semester** : 6th Semester (3rd Year)	
Name of the Teacher : Dr.Satish Vaishnav		**Subject Code** : EE6T002	
Subject : Advance Control System		**Section** :	
Periods per Week (1 hour)		**Lecture**	**3**
		Tutorial	**1**
		Practical	

Course Objective	Course Outcomes
	CO1: To remember the basic concepts of compensation, State variable representation, Controller Tuning, CO2: To understand the performance of compensators, State variable analysis, parameter optimization, Controller tuning, Nonlinear Control System, Digital Control system. CO3: To apply different concepts to find STM, Solution of State Equation, controllability, observabilit, stability of non-linear control system, CO4: To analyze the performance of compensators, to investigate Controllability and Observability of the system, digital control systems using the Z-transformation, and nonlinear system using the describing function technique and phase

	plane analysis CO5: To evaluate STM,Solution of State Equation, Describing functions, effect of sampling period on transient response CO6: To design compensators, SVF and construction of Trajectory

Sr. No	Lec. No	Topic Code	Contents to be Covered	Planned Teaching Dates	Text Books (Page no) Reference Book (Page no)	URL's (NPTEL/OnlineMaterial /PPt/Video)	Applications (R&D/ Industry)	Learning Outcomes	CO mapping
Unit IV– PID Controllers									
		4.1	Revision from Control System I		T1 (200 – 224)	https://www.youtube.com/watch?v=vWzUnJwQG6o		Students should understand Block Diagram, Transfer Function, Time Response,	
		4.2	Revision from Control System I		T1 (200 – 224)	https://www.youtube.com/watch?v=vWzUnJwQG6o			
		4.3	Introduction to P,I,D Controller		T1(165 - 168	https://www.youtube.com/watch?v=nBAXf3r12wM		Students should understand P,I and D Controller	
		4.4	Individual effect on overall System Performance					Students should understand Effect of P,I and D Controller on system performance	
		4.5	P,PI and PID Control& effect on overall system performance			https://www.youtube.com/watch?v=nBAXf3r12wM		Students should understand Effect of P,I D Controller	
		4.6	Numerical Examples						
		4.7	Tuning of PID Controller						

Unit V Nonlinear Control System									
		5.1	jump resonance		(T1)585			Students should understand the phenomenon	
		5.2	Types of non - linearities.		(T1)588-592	https://www.youtube.com/watch?v=c8sIaLjJ		Students should learn different types of Nonlinearities	
		5.3	Describing function analysis and its assumptions.		(T1)625-626			Students should understand the concept of Describing Function method	
		5.4	Describing function of some common non-Linearities		(T1)627-(T1)641	https://www.youtube.com/watch?v=NtRhLIJPDsE		Students should understand how to apply DB analysis to common Nonlinearities	
		5.5	Problems						
		5.6	Problems						
		5.7	Problems						
		5.8	Limit cycles		(T1)606-607	https://www.youtube.com/watch?v=w9hWgSHR__M		Students should undertand the limit cycle behaviour	
		5.9	Limit cycles			https://www.youtube.com/watch?v=w9hWgSHR__M			
		5.10	Singular Points		595-600			Students should learn different types of Singular points	
		5.11	Stability from nature of singular points.		604 - 606			Students should learn to analyse the stability from singular points	
		5.12	Isocline method		613-616	https://www.youtube.com/watch?v=vEeN9vwSg6o		Students should understand the construction of Phase Trajectory	
		5.13	Delta method.		617-618			To understand the construction of Phase Trajectory	
Unit II Design by State Variable									
		2.1	Review of state variable representations		T 1(441- 471)	https://www.youtube.com/watch?v=d34nosv-_uc		Students should be able to obtain different state variable form	

1		2.2	Concept of State and state variable		(T1)449 - 452				
3		2.3	General form 0f state Equation		452-455	https://www.youtube.com/watch?v=ibhwKT6l_Os		Students should learn to derive the State Equation	
4		2.4	Formulation of state Equation for physical system		457 -460				
5		2.5	RLC Network, Armature controlled and field controlled DC Servomtor		457-460				
		2.6	diagonalization of state model		472			Students should be able to Diagonalize system matrix	
		2.7	eigen values and eigen vectors		472-478			To learn about Eigen Values and Eigen Vectors	
		2.8	generalized eigen vector		478-481			To learn the concept about Generalized Eigen Vector	
		2.9	properties of state transition matrix (STM) Power Series Method		483-486	https://www.youtube.com/watch?v=5hPivwvZRn8		Able to compute STM by Laplace transform	
		2.10	Computation of STM by Laplace transform		485-486				
		2.11	Computation of STM by Cayley Hamilton theorem		490-493			Abble to compute STM by Cayley Hamilton theorem	
		2.12	Solution of state equation.		481-483	https://www.youtube.com/watch?v=6iqj_vUxMXc		How to evaluate solution of a state equation	
		2.13	Problems						
		2.14	Problems						
		2.15	Concept of Controllability and Observability		493	**https://www.youtube.com/watch?v=BEngBq49Ibo**		To study the definition of Controllability and Observability	
		2.16	Gilbert's test & Kalman's test for Controllability		494-499			How to apply the tests to evaluate Controllability	

		2.17	Gilbert's test & Kalman's test for Observability, Duality		500-502			How to apply the tests to evaluate Obserability	
		2.18	Effect of state feedback on controllability and observability		504-509	https://www.youtube.com/watch?v=BEngBq49Ibo		To understand the effect of State feedback	
		2.19	Problems						
		2.20	Problems						
Unit I Compensation									
24		1.1	Introduction from Control System I		(T1) 207 – 221 244-264			To understand splane representation, Root Locus and Bode plot	
25		1.2	Need for compensation		320 - 328			To understand compensation and its need	
26		1.3	Performance Analysis of Lead Compensators in time & frequency domain, Bode Plots of Lead Compensators.		328 – 331	https://www.youtube.com/watch?v=RCSsVQF5yg4		To understand general form of Lead Compensator and its realization using Electrical Network,Bode plot	
27		1.4	Performance Analysis of Lag Compensators in time & frequency domain, Bode Plots of Lag Compensators.		331-332	https://www.youtube.com/watch?v=RCSsVQF5yg4		To understand general form of Lag Compensator and its realization using Electrical Network,Bode plot	

28		1.5	Performance Analysis of Lag-lead Compensators in time & frequency domain, Bode Plots of Lag-lead Compensators.		333-334	https://www.youtube.com/watch?v=RCSsVQF5yg4		To understand general form of Lag Lead Compensator and its realization using Electrical Network,Bode plot	
Unit III Optimal Control System									
		3.1	Performance Indices		223 - 226			To understand the concept of PI	
		3.2	Parameter Optimisation without Contraints		665- 666	http://youtu.be/THUQ-avgBjM		To learn parameter optimization without parameter	
		3.3	Problems						
30		3.4	Parameter Optimisation without Contraints		670- 671	http://youtu.be/THUQ-avgBjM		To learn parameter optimization with parameter	
		3.5	Problems						
Unit VI Digital Control System									
31		6.1	Representation SDCS, Sampler & Hold circuit		385- 386	https://www.youtube.com/watch?v=e9OEp5lJA4U		To understand basics of SDCS	
32		6.2	Shanon's Sampling theorem		387-390			To understand the theorem	
33		6.3	Z-Transform		393-402			To understand about Z transform and its application	
34		6.4	Inverse Z-Transform and solution of Differencial Equations		407-410			To understand about Inverse Z transform and its application	
35		6.5	Z' & 'S' domain relationship		423-424			To study Z' & 'S' domain relationship	
36		6.6	Stability by Bi-linear transformation & Jury's test.		424-431			To learn the stability analysis	
		6.7	Controllability and Observability of		522	https://www.youtube.com/watch?v=bnkwDii4K		To study for Discrete time system	

			Discrete time systems.			Nw			
		6.8	revision						

*T=Text Book; R= Reference Book; C= Company name; R= Research Paper

Total number of lectures as per syllabus: - 48 Total number of lectures as per planned: -

Tutorial Plan			
Week	**Topic**	**No. Of Problems**	**Mapped With CO**
	State Space reprepresentation, Diagonalisation, Solution of State Equation, Controllability, Observability	04	
	PID Controller	01	
	Nonlinear Control System	05	
	Optimal Control System	02	
	Digital Control System	01	

Assignment Plan				
Assignment No.	**Topic**	**Given Date**	**Submission Date**	**Mapped With CO**
1	Tuning of PID Controller	30/03/22	05/04/22	
2				

Content Beyond Syllabus Topic – Planned

Sr. No.	Content Beyond Syllabus Topic	Date Given	Mapped with CO's not covered in TP
1	Individual effect of P.I,D,PD and PID Controller	30/03/22	
2			

Text Books / Reference Books:

Code	Title of the Book	Author Name/Designation/ Organization	Publisher	Edition/ Publication Year
T1	Control System Engineering	Nagrath & Gopal New Age International	New Age International	
R1	Modern Control System Engg	K. Ogata	Prentice Hall, India	

Company/Industry:

Code	Company/Industry Name	Website	Detailed Information
C1	Liberatherm Instruments PVT. LTD	www.temraturecontrol.co.in	Mumbai, India
C2	A.S.Automation & Controls	www.asautomationpune.com	Pune, India
C3			

Research Paper:

Code	Title of the Paper	First Author Name	Journal/Conference Name	DOI no.	Issue/Volume/Page no/Year
P1	An Introduction to control system - Semantic Scholar	Article	http://www.ent.mrt.ac.lk/~rohan/teaching/EN5001/Reading/DORFCH1.pdf		
P2					

Dr. Satish Vaishnav
Subject Teacher

Prof.Ashutosh Joshi
Academic Incharge

Dr.Satish Vaishnav
Head of Department

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Department Of Electrical Engineering
"Igniting minds to illuminate the world"
2021-22 (Odd Sem)

VISION	MISSION
"To develop competent and committed Electrical Engineers to serve the society"	1. To impart quality education in the field of Electrical Engineering. 2. To be excellent learning center through research and industry interaction.

Teaching Plan

Course	**:** B. Tech in Electrical Engineering	**Year/Semester**	**:** 7th Semester (4rd Year)
Name of the Teacher	**:** Mr.Mandar S. Isasare	**Subject Code**	**:** BTEEC702
Subject	**:** High Voltage Engineering	**Section**	**:** A
Periods per Week (each 45 min)		**Lecture**	**3**
		Tutorial	**-**
		Practical	**2**

Course Objective	Course Outcomes
1. To study conduction and breakdown in gases, liquids and solids. 2. To understand the methods and measurement of high voltage generation and measurement 3. To explain the lightening phenomenon and insulation co-ordination. **4.** To know different non-destructive testing and standards in HV.	1. Illustrate the concept of electric field stresses, applications of insulating materials and methods for Non-destructive testing of equipment like transformers, insulators, isolators, bushings, lightning arrestors, cables, circuit breakers and surge diverters. 2. Explain the breakdown process in solid, liquid, and gaseous materials 3. Analyze methods for generation and measurement of High Voltages and Currents (both ac and dc) 4. Describe the phenomenon of over-voltage and choose appropriate insulation coordination levels based on IS & IEC Standards

Sr. No		Topic Code	Contents to be Covered	Planned Teaching Dates	Text Books Reference Book (Page no)	URL's (NPTEL/OnlineMaterial/PPt/Video)	Applications (R&D/ Industry)	Learning Outcomes	CO mapping
UNIT I: INTRODUCTION TO HIGH VOLTAGE ENGINEERING									
1	1	1.1	Electric Field Stresses,Poisson's equation, Estimation and Control of Electric Stress			https://www.slideshare.net/mohammedalmatri7/streamer-theory https://nptel.ac.in/courses/108104048/10 https://www.youtube.com/watch?v=wo7XDN2A8KE		**Student will be able to learn basics of high voltage engineering.**	CO1
2	2	1.2	Surge Voltages, their distribution and control.			https://www.slideshare.net/mohammedalmatri7/streamer-theory https://nptel.ac.in/courses/108104048/10 https://www.youtube.com/watch?v=wo7XDN2A8KE		**Student will be able to learn basics of high voltage engineering.**	CO1
UNIT II:CONDUCTION & BREAKDOWN IN GASES									
3	3	2.1	Gases as insulation media, ionization processes			https://www.youtube.com/watch?v=2pLJ2ZX4By4 https://www.youtube.com/watch?v=POmmmCTQ4Xc https://id.elsevier.com/as/OVOFs/resume/as/authorization.ping	C4	**Student will be able to learn** the electrical breakdown phenomenon in gases, and principles of application of these material in the design of high voltage insulation	CO2
4	4	2.2	Townsend's current growth equation, current growth in presence of secondary processes			https://www.youtube.com/watch?v=2pLJ2ZX4By4 https://www.youtube.com/watch?v=POmmmCTQ4Xc https://id.elsevier.com/as/OVOFs/resume/as/authorization.ping	C4	**Student will be able to learn** the electrical breakdown phenomenon in gases, and principles of application of these material in the design of high voltage insulation	CO2
5	5	2.3	Townsend's criterion for		T1 22-27,	http://www.vssut.ac.in/lecture_note	C4	**Student will be able**	

			B.D. Break down in electro-negative gases, Time-lag for B.D.;		37	s/lecture1423723357.pdf https://www.youtube.com/watch?v=-mPWa0F-L44		**to learn** the electrical breakdown phenomenon in gases, and principles of application of these material in the design of high voltage insulation	
6	6	2.4	Streamer theory for B.D in gases, Paschen's law;		T127-38	https://www.slideshare.net/mohammedalmatri7/streamer-theory https://nptel.ac.in/courses/108104048/10 https://www.youtube.com/watch?v=wo7XDN2A8KE	C4	**Student will be able to learn** the electrical breakdown phenomenon in gases, and principles of application of these material in the design of high voltage insulation	CO2
7	7	2.5	B.D in non-uniform field. Corona discharges corona under positive & negative polarities,		T134-36	https://www.youtube.com/watch?v=2pLJ2ZX4By4 https://www.youtube.com/watch?v=POmmmCTQ4Xc https://id.elsevier.com/as/OVOFs/resume/as/authorization.ping	C4	**Student will be able to learn** the electrical breakdown phenomenon in gases, and principles of application of these material in the design of high voltage insulation	CO2
8	8	2.6	Glow & arc discharge, Considerations in using gases for insulation purpose.		T137-38, 68	https://www.sciencedirect.com/topics/engineering/vacuum-insulation-panel https://www.va-q-tec.com/en/technology/vacuum-insulation-panels/	C4	**Student will be able to learn** the electrical breakdown phenomenon in gases and principles of application of these material in the design of high voltage insulation	CO2
UNIT III: BREAKDOWN IN DIELECTRIC MATERIALS									
9	9	3.1	Conduction & breakdown in liquid dielectrics: Pure and commercial liquids, breakdown in pure and		T138-44	https://slideplayer.com/slide/4900533/ https://www.quora.com/What-is-a-liquid-insulator-in-electricity	C4	**Student will be able to learn** the electrical breakdown phenomenon in liquids and principles	**CO**

			commercial liquids					of application of these material in the design of high voltage insulation	
10	10	3.2	theories of breakdown in liquids			https://www.chegg.com/homework-help/definitions/traveling-waves-on-transmission-lines-4 https://www.youtube.com/watch?v=eu1PC4botbM			
11	11	3.3	Breakdown in solid dielectrics Intrinsic, electromechanical &.thermal B.D.,		T1 51-59	http://www.eeeguide.com/intrinsic-breakdown/ https://www.youtube.com/watch?v=az5jDjbDDdA	C4	**Student will be able to learn** the electrical breakdown phenomenon in solid dielectric and principles of application of these material in the design of high voltage insulation	
12	12	3.4	chemical, electrochemical deterioration,			https://www.chegg.com/homework-help/definitions/traveling-waves-on-transmission-lines-4 https://www.youtube.com/watch?v=eu1PC4botbM		**Student will be able to learn** the electrical breakdown phenomenon in liquids and principles of application of these material in the design of high voltage insulation	
13	13	3.5	treeing, tracking, internal discharges,			https://www.chegg.com/homework-help/definitions/traveling-waves-on-transmission-lines-4 https://www.youtube.com/watch?v=eu1PC4botbM		**Student will be able to learn** the electrical breakdown phenomenon in liquids and principles of application of these material in the design of high voltage insulation	

14	14	3.6	B.D. in composite dielectrics.		T1 50-59	https://youtu.be/Yls3-NOuxnw?list=PL-hzttBtzjbhijT8z0mk4NaOEfDAz4R9	C4	**Student will be able to learn** the electrical breakdown phenomenon in solid, liquid and gaseous dielectric and principles of application of these material in the design of high voltage insulation	
15	15	3.7	properties of solid insulators & other materials used in practice.			https://www.chegg.com/homework-help/definitions/traveling-waves-on-transmission-lines-4 https://www.youtube.com/watch?v=eu1PC4botbM		**Student will be able to learn** the electrical breakdown phenomenon in liquids and principles of application of these material in the design of high voltage insulation	
16	16	3.8	Insulating materials: In power transformers, rotating machines, circuit breakers, cables, power capacitors & other equipment			https://www.chegg.com/homework-help/definitions/traveling-waves-on-transmission-lines-4 https://www.youtube.com/watch?v=eu1PC4botbM		**Student will be able to learn** the electrical breakdown phenomenon in liquids and principles of application of these material in the design of high voltage insulation	
UNIT IV: OVER VOLTAGE DUE TO LIGHTENING PHENOMENON:									
17	17	4.1	Natural causes for over voltages – Lightning phenomenon,			https://www.youtube.com/watch?v=C3y289F1eQ4 https://circuitglobe.com/lightning-stroke.html		Students will be able to design a simple protection system for a section of power system, such as a feeder, a transformer or a motor.	

18	18	4.2	Overvoltage due to switching surges, system faults and other abnormal conditions,			https://slideplayer.com/slide/4900533/ https://www.quora.com/What-is-a-liquid-insulator-in-electricity		Students will be able to design a simple protection system for a section of power system, such as a feeder, a transformer or a motor.	
19	19	4.3	propagation of lightning voltage & current waves on transmission lines,		T1 231-240	https://www.chegg.com/homework-help/definitions/traveling-waves-on-transmission-lines-4 https://www.youtube.com/watch?v=eu1PC4botbM		Students will be able to learn Insulation coordination and calculations for the design of simple high voltage insulation system	
20	20	4.4	reflection & transmission of traveling wave at junction			https://www.geneseo.edu/~mclean/simulations/traveling/ReflandTx.pdf https://www.youtube.com/watch?v=rr2auVyFFE8		Students will be able to design a simple protection system for a section of power system, such as a feeder, a transformer or a motor.	
21	21	4.5	system control of over voltage due to switching			https://rmd.ac.in/dept/eee/sp/7/PSG/unit1.pdf https://www.electronicdesign.com/power/high-side-switch-provides-overvoltage-protection-only-four-components		Students will be able to design a simple protection system for a section of power system, such as a feeder, a transformer or a motor.	
22	22	4.6	protection of transmission lines against over voltage.			https://circuitglobe.com/lightning-arrester.html https://www.berkeys.com/2016/11/18/surge-arrester-works/		Students will be able to design a simple protection system for a section of power system, such as a feeder, a transformer or a motor.	

23	23	4.7	Insulation coordination, surge diverters,		T1 257-263	https://www.electrical4u.com/insulation-coordination-in-power-system/ https://nptel.ac.in/courses/108108099/3	C4	Students will be able to learn Insulation coordination and calculations for the design of simple high voltage insulation system	
24	24	4.8	equipment insulation level & co-ordination of substations			https://www.electrical4u.com/insulation-coordination-in-power-system/ https://nptel.ac.in/courses/108108099/3		Students will be able to design a simple protection system for a section of power system, such as a feeder, a transformer or a motor.	
UNIT V: GENERATION & MEASUREMENT OF HIGH VOLTAGES & CURRENTS									
25	25	5.1	Generation of a) high d. c voltage b) power frequency high alternating voltage, ,		T1 79, 86	https://www.youtube.com/watch?v=DI8Yt1AQrH8	C1	Students will be able to learn the principles behind generating high DC, AC and impulse voltages and also different methods of generation of high voltage and currents in laboratory	
26	26	5.2	c) high frequency a. c. d) impulse voltages			https://nptel.ac.in/courses/108104048/24 https://slideplayer.com/slide/10496818/	C1	Students will be able to learn the principles behind generating high DC, AC and impulse voltages and also different methods of generation of high voltage and currents in laboratory	
27	27	5.3	Standard impulse waves shapes and it's equation,			https://nptel.ac.in/courses/108104048/28 http://www.eeeguide.com/standard-	C1	Students will be able to learn the principles behind generating	

						impulse-wave-shapes/		high DC, AC and impulse voltages and also different methods of generation of high voltage and currents in laboratory	
28	28	5.4	multistage impulse generator matrix circuit			https://www.brainkart.com/article/Tripping-and-Control-Of-Impulse-Generators_12908/	C1	Students will be able to learn the principles behind generating high DC, AC and impulse voltages and also different methods of generation of high voltage and currents in laboratory	
29	29	5.5	generation of switching surges, tripping & control of impulse generators,			https://www.youtube.com/watch?v=5Ba4ml-0l5o https://www.brainkart.com/article/Tripping-and-Control-Of-Impulse-Generators_12908/	C1	Students will be able to learn the principles behind generating high DC, AC and impulse voltages and also different methods of generation of high voltage and currents in laboratory	
30	30	5.6	generation of impulse currents		T1 120-121	https://www.youtube.com/watch?v=5Ba4ml-0l5o	C1	Students will be able to learn the principles behind generating high DC, AC and impulse voltages and also different methods of generation of high voltage and currents in laboratory	
31	31	5.7	Measurement of High Direct Current voltages, Abraham Voltmeter			https://www.slideshare.net/touchaman/measurement-of-highvoltageandhighcurrentunitivfullversion https://slideplayer.com/slide/4881706/	C2	Students will be able to learn different methods of measurement of high voltage and currents in laboratory and to select appropriate hardware for certain	

								applications in power system protection and high voltage engineering	
32	32	5.8	Measurement of High Voltages alternating and impulse		T1 149	https://www.slideshare.net/VINEETHKUMARPK/10ee73-high-voltage-engg-chapter-6-part-b-hv-measurements https://slideplayer.com/slide/5792941/	C2	Students will be able to learn different methods of measurement of high voltage and currents in laboratory and to select appropriate hardware for certain applications in power system protection and high voltage engineering	
33	33	5.9	Measurement of High Currents-direct, alternating and Impulse,		T1 159-	https://nptel.ac.in/courses/108108099/35 http://vlabs.iitkgp.ac.in/vhvlab/html/pages/HV&InsulationLectureNotes/MeasHV.pdf	C2	Students will be able to learn different methods of measurement of high voltage and currents in laboratory and to select appropriate hardware for certain applications in power system protection and high voltage engineering	
34	34	5.10	, Oscilloscope for impulse voltage and current measurements			https://www.youtube.com/watch?v=5Ba4ml-0l5o https://www.brainkart.com/article/Tripping-and-Control-Of-Impulse-Generators_12908/		Students will be able to learn the principles behind generating high DC, AC and impulse voltages and also different methods of generation of high voltage and currents in laboratory	
UNIT VI:NON DESTRUCTIVE TESTING									
35	35	6.1	I.E.C. & IS codes for high voltage tests on electrical appliances &			https://nptel.ac.in/courses/108105104/17		Students will be able to learn Different methods of non	

			power apparatus			http://www.cirprotec.com/Support/Knowledge-area/Transient-and-power-frequency-overvoltage-protection/POP/Power-frequency-overvoltages-POP		destructive and High Voltage testing of apparatus. and measurement	
36	36	6.2	I.E.C. & IS codes for high voltage tests on electrical motors			https://nptel.ac.in/courses/108105104/17 http://www.cirprotec.com/Support/Knowledge-area/Transient-and-power-frequency-overvoltage-protection/POP/Power-frequency-overvoltages-POP		Students will be able to learn Different methods of non destructive and High Voltage testing of apparatus. and measurement	
37	37	6.3	Non- destructive testing, testing of insulators		T1 188	https://www.youtube.com/watch?v=aORHxq0feYo https://study.com/academy/lesson/how-to-measure-dc-resistivity.html		Students will be able to learn Different methods of non destructive and High Voltage testing of apparatus. and measurement	
38	38	6.4	Testing of bushings, circuit. breakers		T1 169-178	http://www.electricalidea.com/testing-of-insulator/ https://www.youtube.com/watch?v=6qf1D4ekk6A https://nptel.ac.in/courses/108108099/12		Students will be able to learn Different methods of non destructive and High Voltage testing of apparatus. and measurement	
39	39	6.5	Testing of Isolators, , cables, transformer		T1 169-178	http://www.eeeguide.com/high-voltage-test-on-circuit-breaker-and-isolators/ https://www.youtube.com/watch?v=4L0ch0-Paq8 https://www.electrical4u.com/transformer-testing-type-test-and-routine-test-of-transformer/		Students will be able to learn Different methods of non destructive and High Voltage testing of apparatus. and measurement	
40	40	6.6	layout of high voltage laboratories & test			https://www.youtube.com/watch?v=5Ba4ml-0l5o		Students will be able to learn Different	

			facilities			https://www.brainkart.com/article/Tripping-and-Control-Of-Impulse-Generators_12908/		methods of non destructive and High Voltage testing of apparatus. and measurement	

*T=Text Book; R= Reference Book; C= Company name; R= Research Paper

Total number of lectures as per syllabus: - 40 Total number of lectures as per planned: - 40

Assignment Plan

Assignment No.	Topic	Given Date	Submission Date	Mapped With CO
1	Introduction to HVE/Breakdown mechanism in Gaseous Di-electric	01/10/2021	08/10/2021	1,2
2	Breakdown In Dielectric Materials/ Over Voltage Due To Lightening Phenomenon	1/12/2021	06/12/2021	1,2

Content Beyond Syllabus Topic – Planned

Sr. No.	Content Beyond Syllabus Topic	Date Given	Mapped with CO's not covered in TP
1	Breakdown mechanism in Vaccum Dielectric	10/11/2021	1,2

Text Books:

Code	Title of the Book	Author Name/Designation/ Organization	Publisher	Edition/ Publication Year
T1	High voltage engineering	C. L. Wadhwa	New Age International	2017
T2	High voltage engineering	M. S, Naidu and V. Kamaraju	TMG	

Reference Books:

Code	Title of the Book	Author Name/Designation/ Organization	Publisher	Edition/ Publication Year
R1	High Voltage Technology L.L. Alston Oxford University Press	First Indian	L.L. Alston Oxford University Press	
R2	High voltage engineering	C.L. Wadhwa	New Age International Publishers, Third Edition, 2010	

Company/Industry:

Code	Company/Industry Name	Website	Detailed Information
C1	DNV GL	https://www.dnvgl.com	The KEMA High-Voltage Laboratory is a well-known independent laboratory for testing and certification of medium and high voltage components used in the electrical infrastructure.
C2	Beijing Huatian Mechanical-Electrical Institute Co., Ltd. (BHT)	http://www.bhthv.com	BHT is a company subordinated to China Aerospace Science and Industry Corporation (CASIC) and a high and new technology enterprise, which is dedicated to the research, design and manufacturing of test and detection equipment in high-voltage industry. The main products of the company include surge voltage generator complete test equipment, surge current generator complete test equipment, high-voltage DC generator complete test equipment, power frequency test equipment and transformer comprehensive test station etc. as well as relevant computer control and measurement instruments and meters of various high-voltage detection and test equipment.
C3	North Star High Voltage	http://www.highvoltageprobes.com	North Star High Voltage develops and manufactures high voltage probes which define the state of the art in high voltage measurements. We also develop and manufacture support circuits for closing tubes including Thyratrons and Ignitrons (Thyratron drivers and Ignitron drivers).
C4	Kumtek	www.kumtek.com	In 1989, Kumtek began the business with the purpose of selling non-asbestos high-temperature resistant materials for local major industries in Taiwan. That is still one of Kumtek's main focus today. They have continuously and consistently endeavored to achieve our goal of being "One Stop for Customer's needs in the field of high-temperature insulation protection materials and fabricated products.

Research Paper:

Code	Title of the Paper	First Author Name	Journal/Conference Name	DOI no.	Issue/Volume/Page no/Year
P1	**High Voltage Engineering and Testing**	H.M. Ryan	IEEE Power Engineering Review	https://doi.org/10.1109/MPER.1995.365074	Volume: 15 , Issue: 3 , March 1995)

Mr._____
Subject Teacher

Mr._____
Academic Incharge

Dr./Mr._____
Head of Department,_____