#### First Semester ( 4years B.Tech(exit) and DD)

Sl.	Course Name	Coursec	Class Load/Week		ek	Credit	Class	Marks
No		ode					load/week	
			L	Т	Р			
1.	Mathematics –I	MA1101	3	1	0	4	4	100
2.	Chemistry/Physics	CH1101/ PH1101	3/4	0	0	3/4	3/4	100
3.	Basic Electrical Engineering / Introduction to Computing	EE1101/ CS1101	3	1	0	4	4	100
4.	Mechanics/Ecology & Environment	AM1101/ CE1101	4/3	0	0	4/3	4/3	100
5.	English/Sociology &Professional Ethics	HU1101/ HU1102	3	0	0	3	3	100
	Theory Sub-total		16/17	2	0	18/17	18/17	500
6.	Chemistry Lab/Physics Lab	CH1171/ PH1171	0	0	3	2	3	50
7.	Basic Electrical Engineering	EE1171/	0	0	3	2	3	50
	Laboratory / Computer Laboratory	CS1171						
8.	Drawing/Workshop		0	1/0	3	3/2	4/3	50
9.	NSS/NCC/PT/Yoga					R*		
	Practical Sub-total		0	1/0	9	7/6	10/9	200
	First Semester Total					25	28	700

\*R:Required (Non-credit but with grade)

## Second Semester ( 4 years B.Tech(exit) and DD)

Sl.	Course Name	Course	Class Load/Week		eek	Credit	Class load/	Marks
No		code					week	
			L	Т	Р			
1.	Mathematics-II	MA1201	3	1	0	4	4	100
2.	Physics/Chemistry	PH1201/ CH1201	4/3	0	0	4/3	4/3	100
3.	Intro to Computing / Basic Electrical Engineering	CS1201/ EE1201	3	0	0	3	3	100
4.	Ecology & Environment/Mechanics	CE1201/ AM1201	3/4	0	0	3/4	3/4	100
5.	Sociology & Professional Ethics/	HU1202/	3	0	0	3	3	100
	English	HU1201						
	Theory Sub-total		17/16	1	0	17/18	17/18	500
6.	Physics Lab/Chemistry Lab	PH1271/ CH1271	0	0	3	2	3	50
7.	Computer Lab/ Basic Electrical Engineering Lab	CS1271/ EE1271	0	0	3	2	3	50
8.	Workshop/Drawing	WS1271/ AM1271	0	0/ 1	3	2/3	3/4	50
9.	NSS/NCC/PT/Yoga	SA1271				R*		
	Practical Sub-total		0	0/1	9	6/7	9/10	200
	Second Semester Total					23	26	700

\*R:Required(Non-credit but with grade)

Kowhe Das (Blattackarya)

## **Basic Electrical Engineering (EE1101/1201)**

**Prerequisite:** Fundamental of Physics

#### Weekly contact: 3-1 - 0(L - T - P)

#### Full Marks: 100

#### Credits:04

Module No.	Module Name and Topics	No. of Lecture- hrs
1.	<b>DC Circuits:</b> Node, branch, active& passive elements, linear and non linear circuits, bilateral network, Kirchoff's laws, Maxwell's loop current method, star-delta trans formation. Network theorems–Super position theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem.	6
2.	<b>Measuring Instruments:</b> Discussion on common Electrical Laboratory Instruments (Ammeter, Voltmeter, Wattmeter)-Classification, torques in the instruments; Mention of digital meters.	3
3.	<b>Magnetics:</b> Magnetic quantities, B-H curve, calculation on magnetic circuits, analogy with electric circuit, iron losses.	3
4.	<b>AC Fundamentals:</b> Sinusoidal quantities, phase and phase difference, average and RMS values, form factor and peak factor, concept of phase or diagram, impedance and admittance, power and power factor.	6
5.	<b>AC Circuits :</b> Single-Phase–V-I relationship in R-L-C circuit, R-L,R-C, series and parallel combinations of R, L & C, phase or diagram, apparent, active and reactive power, series resonance, Three-Phase-Balanced system, star and delta connections, phase and line quantities and their relationships.	6
6.	<b>Distribution of Electricity:</b> Basic Distribution and Wiring System, Use of Switch Fuse Unit, MCB, earthing and protection;	2
7.	<b>Transformers :</b> Constructional parts, types, ratings and specifications, emf equation, concept of transformer emf, phasor diagrams, equivalent circuit, concepts of losses, temperature rise, cooling, efficiency, voltage regulation. Mention of three phase transformers.	6
8.	<b>DC Machines:</b> Construction, types, operating principles(motoring and generating modes), ratings and specifications, torque and emf equations(derivation not required), elementary principles of speed-control of DC motor, Applications of DC motor	4
9.	<b>Induction Motor:</b> Three-phase Induction Motors –operating principle ,types, ratings and specifications, slip; torque-speed characteristic curve	3
	Total:	39L+13T

Text Books:

1. A course in Electrical Engineering: Volume I- Direct Currents; Volume II- Alternating Current by Chester L.Dawes ,Mc Graw Hill

2. **Basic Electrical Engineering** by V.N. Mittal and Arvind Mittal, Second Edition, 2005, Tata McGraw-Hill Education

3. Electrical Engineering Fundamentals byDelToro,1972,Prentice-Hall

4. Advanced Electrical Technology byIICotton, 1990, ReemPublications(P)Limited

5. Electrical and electronicTechnologybyHughes,2005,PearsonPrenticeHall

6. Electric Circuits by J.Edminister and M. Nahvi,2005,McGrawHill

#### Webresource

1.http:ntpl.iitm.ac.in/course/Webcourse-contents/IIT%20kharagpur/Basic%20Technology/New\_index1.html

Kowhe Das (Blattackarya) H.O.D., EE Reference books;

1. Applied Electricity for Engineers by I.Bessonow,1973,Izdat.Mir

2. Introductory ElectricalEngineeringbyGeorgeF,Corcoran&HenryR.Reed,1957,Wiley

3. Alternating current circuits 4<sup>th</sup>editionbyRusselM,

Kerchner&GeorgeF.Corcoran,4<sup>th</sup>Edition,1960,JohnWiley&SonInc

4. Engineering CircuitAnalysisbyHayt&Kemmerly1971,McGraw-Hill

Book on electrical engineering problems with answers:

1. Problems in Electrical Engineering by Stanley Parker Smith,9<sup>th</sup>Edition,CBSpublishersanddistributors

## **BASIC ELECTRICAL ENGINEERING LABORATORY (EE-1171/1271)**

Weekly Contact: 0-0-3(L-T-P)

Full Marks:50 Credits: 2

Laboratory experiments based on the subject (Basic Electrical Engineering) (EE1101/E1201)

## <u>3<sup>rd</sup>Semester ( 4yearsB.Tech(exit) and DD)</u>

Sl. No	Course Name	Course code	Class Load/Week			Credit	Class load/week( Total)	Marks
			L	Т	Р			
1.	Mathematics III		3	0	0	3	3	100
2.	<b>Electrica land Electronic Measurements</b> (CoreTheory-I)	EE2101	3	1	0	*	4	100
3.	Electrical Machines I (Core Theory-II)	EE2102	3	1	0	4	4	100
4.	Classical Electrodynamics (Core Theory- III)	EE2103	3	1	0	4	4	100
5.	Signals and Systems (Core Theory-IV)	EE2104	3	1	0	4	4	100
6.	Electro-Technology in Mining (For Mining Students)	EE2105	3	1	0	4	4	100
	Theory Sub-total		15	3	NIL	19	19	500
7.	Measurement Laboratory (Core Lab/Practical-I)	EE2171	0	0	3	2	3	50
8.	Electrical Machines Laboratory – I (Core Lab/Practical-II)	EE2172	0	0	3	2	3	50
9.	Numerical Simulation and Application Tools Laboratory (Core Lab/Practical-III)	EE2173	0	0	3	2	3	50
10.	Electrical Machines Lab for Mining (For Mining Students)	EE2174	0	0	3	2	3	50
11.	Mini Project-I	EE2191	0	0	0	2	0	50
	Practical Sub-total		NIL	NIL	9	8	9	200
	3 <sup>rd</sup> Semester Total					27	28	700

#### **\*Decision Pending**

4<sup>th</sup> Semester( 4yearsB.Tech (exit) and DD)

S1.	Course Name	Course code	C	Class Load/Week		Credit	Class load/	Marks
No							week	
			L	Т	Р			
1.	Electrical Machines–II (Core Theory– V)	<b>EE2201</b>	3	1	0	4	4	100
2.	Network Theory (CoreTheory-VI)	EE2202	3	1	0	4	4	100
3.	Analog Electronics (Core Theory–VII)	EE2203	3	0	0	3	3	100
4.	Control Systems I (Core Theory–VIII)	EE2204	3	1	0	4	4	100
5.	Digital Electronics	EE2205	3	0	0	3	3	100
	Theory Sub-total		15	3	NIL	18	18	500
6.	Electrical Machines Laboratory-II (Core Lab-IV)	EE2271	0	0	3	2	3	50
7.	Digital Electronics and Analog Electronics Laboratory (Core Lab-V)	EE2272	0	0	3	2	3	50
8.	Laboratory on Network Theory (Core lab- VI)	EE2273	0	0	3	2	3	50
9.	Mini Project-II	EE2291	0	0	0	2	0	50
	Practical Sub-total		NIL	NIL	9	8	9	200
	4 <sup>th</sup> Semester Total					26	27	700

## **Electrical and Electronic Measurements (EE2101)**

**<u>Prerequisite</u>:** Basic Electrical Engineering, Fundamentals of Electronics

Weekly Contact: 3-1-0(L-T-P)

Full Marks:100

#### Credits:\*

Module No.	Module Name and Topics	No. of Lecture- hrs
1.	Measurement Errors and Analysis	2
2.	<b>Indicating Instruments:</b> Voltmeter, Ammeter, Range Extension–Shunt and Multipliers, Wattmeter.	4
3	<b>Measurement of Power:</b> Active power: single wattmeter, two wattmeter method, balanced, unbalanced three phase system, Reactive Power: two wattmeter, single wattmeter rmethods.	5
4.	Integrating Instruments: Energy meter, Smart Meter	2
5.	<b>Other Electrical Instruments:</b> Phase angle and power factor meter, frequency meter, synchroscope, meters for kVAh, kVARh, Maximum Demand Indicator, Trivector meter.	5
6.	Measurement of Resistance: Low, medium, high and insulation resistances.	2
7.	<b>Inductance and Capacitance measurement</b> : AC bridges for inductance and capacitance measurement.	4
8.	Magnetic Measurements: Magnetic measurement using Ballistic Galvanometer, Grassot Flux meter, BH curve of magnetic material, separation of losses.	2
9.	<b>Instrument Transformers :</b> Current and Potential transformers, ratio and phase angle errors, design considerations, numerical problem.	4
10.	<b>Electronic Measurements:</b> Electronic voltmeter, multi meter, wattmeter and energy meter. Time, Frequency and Phase Angle meters; CRO, Storage oscilloscope, Spectrum and Wave analyzer.	9
	TOTAL:	39

#### \*Decision Pending

Text Books:

- 1. Modern Electronic Instrumentation and Measurement Techniques, HelfrickandCooper, 1997, Prentice Hall of India, ISBN: 9788120307520, 9788120307520
- 2. Instrumentation Measurement and Feedback, Jones, B.E., 1995, TataMcGraw-Hill. ISBN 0993831
- 3. Electrical Measurement and Measuring Instruments, Golding, E.W., 3<sup>rd</sup>Edition, SirIssacPitmanand Sons.
- 4. Principles of Electrical Measurements ,Buckingham, H.andPrice,E.M.,1959,EnglishUniversity

## **Electrical Machines-I(EE2102)**

**Prerequisites:** Basic Electrical Engineering

#### Full Marks: 100

Credits:4

Module No.	Module Name and Topics	No. of Lecture- hrs
1.	<b>General concepts:</b> Concept of mmf and flux density distribution in machines–pulsating and rotating type. Basics of electromagnetic torque production and concept of torque angle.	3
	DC Machines	
	<b>DC machines :</b> Principle of operation(motor and generator),Construction-geometry, Materials used in different parts like yoke, poles, armature, commutator etc., commutation process, function of brush commutator assembly. Armature winding(idea only).	3
	Armature reaction, demagnetizing and cross-magnetising effects, interpoles and Compensating windings,	2
2.	<b>Generators:</b> No-loadoperation,Magnetisationcurve,OCC,build-upprocessin generators, critical field resistance and critical speed.	2
	Load characteristics of DC generators-sep. excited shunt, series, compound.	2
	<b>Motors:</b> LoadcharacteristicsofDCmotors–sep.excited,shunt,seriesmotors <i>n</i> -T, <i>n</i> -I And <i>T</i> - <i>I</i> characteristics.	2
	Zone softorque-speed plane (voltage/ field control), speed control of DC motors.	2
	<b>Losses and efficiency of DC machines</b> : Swinburne's test, Hopkinson's test, Brake test, heat- run. Mention of type test sand routine tests	3
	International standard sand codes of DC machines (discuss atleast one)	2
	Transformers	
	<b>Principle of operation:</b> Construction of single and three-phase transformers(core and Shell type),Transformeroil,Transformeraccessoriese.g.conservator,breather, Buchholz relay, bushings,Tap changing basics.	2
	Equivalent circuit(perphase), phasor diagrams, per unit system of representation, Voltage regulation for different types of load, maximum voltage regulation and its condition	1 1
	<b>Losses and efficiency</b> : Efficiency load curve and maximum efficiency condition, All Day efficiency.	2
3.	<b>Tests :</b> Polarity test, OC and SC test, Separation of losses, Sumpner test, difference Between type and routine tests.	2
	<b>Three phase connections :</b> star-star, delta-star, delta-delta, star-delta, open delta, zigzag). Vector groups,.	2
	Auto transformer : Principle of operation, Comparison with two-winding transformer.	2
	Parallel operation of single and three-phase transformers. Three winding transformer-Equivalent circuit, Role of tertiary winding.	2
	Phase conversion: 3ph to 6ph, 3ph to12ph, 3-ph to 2-ph (Scott connection), Ferrite Core transformers and sq. wave operation of transformers	2
	National/International Standards and codesof1 &3-phasetrf. (discuss at least one)	2
	TOTAL:	39L+13T

#### Text Books:

WeeklyContact:3-1-0(L-T-P)

- 1. Electrical Machinery, P.S.Bimbhra, 2011, KhannaPublishers, ISBN: 9788174091734, 8174091734
- 2. Electrical Machinery ,S.K. Sen, 1977, KhannaPublishers, India, ISBN-10:8174091521, ISBN-13:978-8174091529
- 3. **Performance and design of AC Machines,** M.G.Say,2002,CBS Publishers and Distributors Pvt.Ltd., ISBN10:8123910274/ISBN13:9788123910277.

- 4. **Electric Machines,** I J Nagrath and D P Kothari,5<sup>th</sup>Edition McGraw Hill Education 2017,ISBN: 978-9352606405
- 5. Electric Machinery, P.K.Mukherjee and S.Chakravorti, 2<sup>nd</sup> Edition, 1993, Dhanpat Rai

#### Reference books:

- 1. Electric Machinery, A.E.Fitzgerald, CharlesKingsley, JR., StephenD. Umans, 6<sup>th</sup>Edition, 2005, McGrawHill;
- **2. Electrical Machinery and Transformer**, Irving L.Kosow, 2<sup>nd</sup> Edition,1991, Prentice Hall, ISBN0132487330, 9780132487337
- 3. Performance and design of DC Machines, Clayton and Hancock , CBS Publishers, ISBN: 9788123909271,9788123909271
- 4. A Course in Electrical Engineering, Volume II, Alternating Currents, ChesterL.Dawes, McGraw-Hill, 1922, ISBN 10:1330312228, ISBN 13:9781330312223
- 5. J and P Transformer Book, Ray Arnold and Martin Heathcote, 14th Edition Newnes Publication, ISBN: <u>978-0080966182</u>

<u>Classical Electrodynamics (EE2103)</u> <u>Prerequisites</u>: Vector Calculus in Mathematics, Electromagnetic Field theory module in Physics and Basics of Electrical Engineering .

Weekly	Contact:3-1-0(L-T-P) Full Marks:100 C	redits: 4
Module No.	Module Name and Topics	No. of lecture- hrs
1.	<b>Preliminaries:</b> Physical interpretation of gradient, divergence and curl. The Laplacianoperator, vector relationship in rectangular, ylindrical and spherical polar coordinates ys tems, divergence and curl equations., Integral forms, Stoke's Theorem, Green's Theorem, Diracde ltadistribution, field as derivative of potential, Helmholtz theorems	8
2.	<b>Electrostatic Field:</b> Coulomb's Law, electrostatic field, Laplace and Poisson's equation, divergence and curl of electrostatic field, scalar potential ,Field equations in different coordinate systems, boundary conditions, Continuity equation and relaxation time, Energy stored due to accumulation of charges	7
3.	<b>Magneto static Field:</b> Lorentz force, Biot-Savart's law, Scalar and vector potentials. Divergence and curl of magnetic field, Ampere's law, Force and Torque equations, field Equations in different coordinate systems. Boundary conditions, magnetic vector potential And flux ,energy stored in a magneto static field	5
	<b>Permanent Magnets:</b> Use, second quadrant B-H curve, load line concept, minimum volume criterion, focusing factor, simple problems. On PM design	3
4.	Dynamic electric and magnetic fields: Time varying fields and Faraday's law.	
	Displacement current, Maxwell's correction to Ampere's law, relation between electric and Magnetic fields	3
	<b>Poynting's Theorem and flow of power</b> : Poynting's theorem and its equivalence to energy conservation law, Poynting's vector, power flow and relevance to power transmission	2
	<b>Wave equation</b> : Maxwell's equations, Wave equations in free space and in conducting medium, Wave impedance	3
5.	<b>Direct implications in Electrical Engineering:</b> Eddy currents, Skin effect, proxymity effect, elements of Electromagnetic fields in Electrical Machines. grain-oriented and non-oriented laminations, Force on conductors in Transformer and machines. Electric discharge, Applications in heating, welding, implications in flow of electrical power through transmission line sand cables,	5
6.	<b>Super conductivity</b> : Elementary concepts, super conducting magnets, super conducting magnetic energy storage, super conducting fault current limiters, super conducting machines and other applications.	3
	Total:	39L+13T

#### Suggested readings(as Text Books first 2or 3from the list and the rest for reference):

- Introduction to Electro dynamics: David J.Griffiths, Cambridge University Press, 2017, 4<sup>th</sup>Ed.ISBN-13: 978-1108420419 & ISBN-10: 1108420419
- 2. **Principles of Electro magnetics:**MatthewN.O.Sadiku,OxfordIntnatl.StudentEdition,2009,4<sup>th</sup>Ed.,ISBN-10:019806229X &ISBN-13:978-0198099154
- SuperconductingMagnets:MartinN.Wilson,ClarendonPress1987,ISBN:9780198548102
   Outlines of Electromagnetics:JosephA.Edminister,Schaum'sSeries,McGraw-
- HillEducation;4edition(16December 2013)**ISBN-10:**0071831479&**ISBN-13:** 978-0071831475
- 5. **Electromagnetism**:JohnC.SlaterandNathanielH.Frank,DoverPublicationsUSA,2015,ISBN-10:0486622630&ISBN-13: 978-0486622637
- Classical Electro dynamics: JohnDavidJackson, Wiley;3<sup>rd</sup>Ed.(2007), ISBN-10:9788126510948&ISBN-13:978-8126510948
- 7. Networks, lines and Fields: John D. Ryder, Pearson Education India,2<sup>nd</sup> Ed. 2015, ISBN10:9789332559516&ISBN-13: 978-9332559516
- 8. **Special Electrical Machines:** K.V.Ratnam, UniversitiesPress; 1<sup>st</sup>Ed.2008,ISBN-10:9788173716317&ISBN-13:978-817371631
- 9. Electromagnetism: R.G. Powell, MacMillan, 1990, ISBN 0-333-48317-0
- Foundations of Electromagnetic Theory: John R. Reitz, Frederick J. Milford & Robert W. Christy, Addison-Wesley4<sup>th</sup> Edition 2008, ISBN-10: 0321581741& ISBN-13:978-0321581747
- 11. Electromagnetic Waves and Radiating Systems : Jordan and Balmain, Prentice Hall India Learning Private Limited, 2<sup>nd</sup> Ed. 1964, ISBN-10:8120300548&ISBN-13:978-8120300545
- 12. Electromagnetic Fields, Energy ,and Forces: Robert M.Fano, LanJenChuand Richard B.Adler, MIT Press2020,ISBN:9780262561709
- 13. Electromagnetic Energy Transmission and Radiation : RobertM.Fano, LanJenChuand RichardB.Adler,MIT Press 2020,ISBN:9780262511407

## Signals and Systems (EE2104)

Prerequisite : Basic electrical engineering , Mathematics

WeeklyC	ontact:3-1-0(L-T-P) Full Marks: 100	Credits: 4
Module No.	Module Name and Topics	No. of Lecture- hrs
1.	<b>Signals:</b> Sources–deterministic and stochastic, dependent and independent sources; Source Transformation; VCVS, VCCS, CCVS, and CCCS; Continuous-time and discrete-time signals, even and odd signals, periodic and a periodic signals, gate functions standard signals and other basic signals ,Energy and power signals.	4
2.	<b>Systems:</b> Interconnection of systems, Types of systems–continuous-time, discrete-time, linear, nonlinear, time-invariant, time-variant, causal, non-causal systems. Stability.	2
3.	<b>Signal Analysis:</b> Complex Frequency and The Laplace Transform Definitions, Transform of common forcing functions. Derivatives and integrals, shifted functions, Initial and Final Value theorems, Inverse Laplace Transform, Convolution integral, Heaviside Theorem.	5
4.	<b>System dynamics:</b> System modeling concepts, Transfer function, block diagram representation; Electrical Analogous networks for Mechanical, Thermal, Hydraulic systems.	4
5.	<b>Transient responses of Passive circuits</b> : (Differential equation approach) – RL, RC, RLC circuits with dc and sinusoidal excitation. Application to transient solution for simple network, switching transients and impulses in networks.	5
6.	Frequency Response of Systems : steady state response due to periodic excitations, Bode plots	4
7.	<b>Fourier Analysis</b> : Fourier series, evaluation of Fourier co-efficients, reference of waveform symmetry, Frequency spectrum, convergence in truncated series, Properties of Fourier analysis, shifting function, Exponential form and Trigonometric form of Fourier series, Line spectrum, steady state responses to periodic signals, a periodic functions, Fourier Integral and continuous spectra: Spectrum envelope for a recurring Pulse, Fourier Integral and Fourier Transform.	10
8.	<b>z-Transform and its applications:</b> definition of z-transform, region of convergence, relationship between z-transform and Laplace transform, Inverse z-Transform	5
	TOTAL	39L+13T

<u>Text Books:</u>

- Signals and Systems, AlanV.Oppenheim, A.S.WillskyandS.H.Nawab, 2<sup>nd</sup> edition, PearsonIndia, 2015, ISBN:-9332550239
- 2. Circuits and Systems, K.M.Soni, S.KKataria&Sons, NewDelhi, 2010, ISBN:-8188458066

#### Reference Books:

- 1. **Networks and Systems**, D.RoyChoudhury, 2<sup>nd</sup>edition, NewAgeInternational(p)Ltd., 2014, ISBN:-9788122427677
- 2. Network Analysis and Synthesis, Franklin. F. Kuo, Studentedition, WileyIndiaPvt. Ltd., 2013, ISBN:-9788126510016
- 3. Network Analysis and Synthesis, C.L. Wadhwa, 3<sup>rd</sup>edition, NewAgeInternational(p)Ltd.2014, ISBN:-8122420362
- 4. **Circuit Theory: Analysis and Synthesis**, A. Chakrabarti, 7<sup>th</sup>revisededition, DhanpatRai&Co, 2018, ISBN:-8177000004

Date: 04/10/2021

## **Electro-Technology in Mining (EE2105)** Pre-requisite: Basic Electrical Engineering (EE-1201)

Weekly Contact: 3-1-0 (L-T-S)

Full Marks: 100

Credits: 4

Sl.		No.of
No.	Module Name and Topics	Lecture-hrs
1.	Electrical Power Transmission and Distribution:	11
	Classical Electrical Power System concept - Centralized Generation,	
	Transmission, Distribution; Radial and ring main distribution, brief	
	overview of DC distribution systems with major stress on AC	
	distribution systems; Overhead and underground systems.	
	Earthing/Grounding. Power factor improvement.	
2.	Underground Cables:	08
	Electrical cables – principles and basic ideas; concept of cable	
	resistance, capacitance and inductance; grading of cables, calculation	
	of size of cables; types, installation and jointing, IS specification for	
	mining cables	
3.	Electrical Motors, Drives and Apparatus used in Mines:	16
	Motors, ratings and their selection; starting and braking of electric	
	motors – elementary ideas; concepts of speed control with stress on	
	solid state drives including Ward-Leonard and ILGNER control,	
	SCR control; Electrical signalling, pilot and control circuits,	
	Electromagnetic and solenoid brakes, safety rules; Special	
	requirements for mining applications like Intrinsically safe and	
4	flame-proof apparatus	
4.	Power System Protection Issues:	11
	Switchgear devices with stress on circuit breakers, their types based	
	on arc quenching medium, ratings and selection; concepts of relays	
	for power system protection, current and potential transformers,	
	surge arrestors	0.2
Э.	Electrical Layout: Electrical layout of a typical mine, single line	02
	diagram, a typical case study	40
	lotal	4ð

## **Suggested Readings:**

- 1. Electro technology in Mining Neuad&Marinovic ,ISBN: 9780444597250,Elsevier Science
- Electric cables Hand book G. F. Moore, ISBN0632040750 (ISBN13: 9780632040759), Published December 8th 1997 by Wiley-Blackwell
- A course in power systems J. B. Gupta, ISBN 818845852X, 9788188458523
   S. K. Kataria& Sons, 2009
- 4. Electrical Power Uppal, **ISBN-13:** 978-8174092380, Khanna; Fifteenth edition (1987)
- 5. Fundamentals of Electrical Drives G. K. Dubey ,ISBN-13: 978-8173194283, Narosa; Second Edition (2010)

## **Measurement Laboratory**

## <u>EE2171)</u>

Class(0-0-3)(L-T-P)

Full Marks -50

Credits:2

Laboratory experiments based on the theory subject

"Electrical and Electronics Measurement (E2101).

**Electrical Machine Laboratory- I(EE2172)** 

Class(0-0-3)(L-T-P)

Full Marks -50

Credits:2

Laboratory experiments related to the subject "Electrical Machine-I(EE2102)".

Numerical Simulation and Application Tools Laboratory (EE2173)

Class(0-0-3)(L-T-P)

Full Marks -50

Credits:2

Laboratory experiments and tutorials on numerical simulation and application tools.

**Electrical Machines Lab for Mining (EE2174)** 

Class(0-0-3)(L-T-P)

Full Marks -50

Credits:2

Laboratory experiments on Electro-Technology in Mining

## <u>Mini Project-I</u>

## <u>(EE2191)</u>

#### FullMarks-50

Credits:2

**General outline :** Preferably, four to five students should form a group and each such group will have to undertake a' Mini Project-I 'in the 3<sup>rd</sup> semester which will continue in the 4<sup>th</sup>semester. A single student also may undertake such a project. The aim of such a 'Mini project' is to make the students aware of the concept of a project as beginners. The group/student should select /identify a specific engineering problem out of abroad area of electrical engineering and plan for its execution, employing scientific methods. The methods should have components of analysis/ synthesis/ design/ simulation/ testing etc. towards the solution of the project problem with a focus to complete the project report should be finally submitted at the end of each semester. Additionally, a seminar on the same must be presented by the group/individual at the end of each semester in front of a board of examiners where each student has to present at least a part of the project. On completion of the seminar, each student will have to answer questions asked by the board of examiners on the project under taken. The evaluation of each student will depend on the work done, report submitted, seminar presentation and the viva-voce examination. The evaluation will test the capability of a student of working in an individual capacity as well as in a group to plan and execute a project.

## Specific requirement for Mini project, 3<sup>rd</sup> Semester:

Class(0-0-0)(L-T-P)

The entire planning for undertaking the total project should be finalized by the end of the  $3^{rd}$  semester. Staring from a broader topic initially chosen, efforts should be undertaken to narrow down and eventually pinpoint the project problem. As fast as possible, the project problem should be clearly identified, formulated and finalized. The objective behind the project must be clearly laid down with justification of the problem identified to be solved. Major activities/modules should be identified with timelines keeping in view contingency measures. Activities must be grouped clearly identifying activities/modules to be undertaken by each candidate. Work scheduling should be so planned that work should be undertaken in individual capacity for some activities/ modules and/or in groups for some others. Financial planning should be made and presented. Existing laboratory support, if needed for any hard ware development/testing etc. in future must be planned and presented. Concrete deliverables of the projects must be identified and mentioned. After this comprehensive planning is over, project execution should start as per the identified activity schedule and time line. At the end of the 3<sup>rd</sup> semester, the project report submitted should include the above-mentioned points and present the work done and progress made with respect to the planned activities. Existing books, data sheets, website URL's, research papers etc., as and when consulted for the project work, should be referenced and cited properly in the project report and in the seminar presentation. The project report should end with specific conclusions as on date and the scope of future work for the 4<sup>th</sup> semester. The seminar presentation to be made should point-wise summarize the content written in the project report.

## **Electrical Machines-II (EE2201)**

 $\underline{Prerequisites}: (i) Basic Electrical Engineering and (ii) Electrical Machines-I at the second year level.$ 

#### Weekly Contact:3-1-0(L-T-P)

Full Marks: 100

#### Credits:4

Module No.	Module Name and Topics	No. of Lecture-hrs
1.	<b>Armature excitation in electrical machines:</b> Concept of uniform and sinusoidal current sheet, MMF waveforms and their amplitude for DC, AC single phase and poly phase winding; Pitch, Distribution and Winding factors	7
2.	<b>Electromagnetic torque:</b> General principles of electromechanical torque Production in doubly excited machines	2
3.	<b>Introduction to Induction Machines (IM):</b> Types, Construction in details, Principle of operation (as motor, generator and brake),concept of slip, rotor frequency, rotor e.m.f during motion	4
4.	<b>Flux-mmf relationship and phasor diagram in IMs</b> : Derivation of per-phase equivalent circuit, measurement of parameters and performance calculation. Operating characteristics of 3-phase induction motor. Effects of varying voltage and Frequency on motor performance	4
5.	Torque-slip characteristics of IMs: Discussions and analysis	2
6.	<b>Circle diagram of IMs</b> : Prediction of the machine performance from circle diagram, limitations of circle diagram	2
7.	<b>High toreque squirrel cage induction motors</b> : Discussions on deep bar and double cage motors and analysis	2
8.	Generating mode of IMs: Working principle of Induction Generators, performance and applications	2
9.	<b>Starting of IMs:</b> Problems associated with induction motor starting, starting methods for squirrel cage and slipring motors	2
10.	<b>Speed control of IMs:</b> Resistance and reactance variation, V/f control, variation of no. of poles, pole amplitude modulation, slip power recovery and exchanges for doubly fed induction machines	3
11.	<b>Space harmonics in IMs:</b> Effects of space harmonics, methods to reduce their disadvantageous effects, slot skewing, skew factor, effect on winding factor	3
12.	<b>Premium efficiency IMs :</b> Cu-rotor IMs, NEMA classification, National/International Standards and codes of Induction machines (discuss at least one)	2
13.	Single phase Induction Motors: Types, operation, performance, applications.	4
	Total:	39L+13T

#### Text Books:

- 1. **The Performance and design of Alternating Current Machines,** M.G.Say, CBS Publishers & Distributors Pvt.Ltd., 2002,ISBN 10:8123910274 /ISBN13:9788123910277.
- 2. Electrical Machinery, P.S.Bimbhra, KhannaPublishers, 2011, ISBN: 9788174091734, 8174091734.

#### **Reference Books:**

- 1. The Performance and design of AC Commutator motors including the single-phase induction motor, EO pen shaw Taylor, New Delhi :Wheeler Publishing, 1971(repr.2000)
- 2. Theory of Alternating Current Machinery, A. S. Langsdorf, Tata McGraw Hill Education, 2001,

ISBN-10:0070994234ISBN-13:978-0070994232

- 3. Electrical Machinery, S.K. Sen, Khanna Publishers, India, 1977, ISBN-10: 8174091521, ISBN-13: 978-8174091529
- 4. A Course in Electrical Engineering, Volume II, Alternating Currents, Chester L. Dawes, McGraw-Hill, 1922, ISBN 10:1330312228, ISBN 13:9781330312223
- 5. Design and analysis of Electric Machines; Kosten koand Piotrovsky
- 6. Alternating-Current Machines. Third Edition, A.F. Puchstein, T.C.Lloyd and A.G.Conrad, New York; Chapman & Hall:London, 1954
- 7. Electric Machinery, A.E.Fitzgerald, Charles Kingsley, JR., Stephen D. Umans, 6th Edition, McGrawHill; 2005

## Net work Theory (EE2202)

Prerequisites: Basic electrical engineering, Signals and systems, Maths-III

Weekly (	Contact : 3-1-0(L-T-P) Full Marks: 100	Credits:4
Module No.	Module Name and Topics	No. of Lecture -Hrs
1.	<b>Network Theorems in AC circuits and for dependent and independent sources</b> : Review of basic Circuit Laws, Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem, Substitution theorem, Compensation theorem, Millman's theorem and Tellegen's theorem.	5
2.	<b>Two-port Network:</b> Network elements – Concepts of ports and terminals; Classification of network, network configuration of network ;Z-,Y-,T-,h- and g-parameters; Conditions of reciprocity and symmetry; Interrelationship of network parameters; Input and output impedances. Inter connections of 2-port networks; Short-circuit and Open-circuit impedances, image impedances, equivalent T-and $\pi$ -network.	8
3.	<b>Network Functions:</b> Driving point and Transfer functions and their properties, computing various driving point and transfer functions of standard networks, concept of poles and zeros, time-domain responses for pole locations in complex s-plane.	3
4.	<b>Coupled Networks:</b> Self and Mutual Inductance, Coefficient of coupling; Connections of coupled coils; Dot convention; Modelling of coupled circuits, Electrical equivalent of magnetically coupled circuits.	3
5.	<b>Elements of Network Topology</b> : Graph of network, concept of branch, node, mesh, tree, co- tree, Planarandnon-planargraphs, incidence, tie-setandcut-setmatrices, inter-relation between various matrices, KCL and KVL in topological form, network solution by node basis and loop basis, principle of duality, related problems.	8
6.	<b>Passive Filter Synthesis</b> :Image and characteristic impedances of a two-port network, propagation constants, classification of filters, prototype T-section and $\pi$ -section filters, Low-Pass, High-Pass, Band-Pass, Band-Reject filters, Design of Constant-K filters, (low pass and high pass), m-derived filters (low pass and high pass); Composite filters.	7
7.	<b>Elements of Passive Network Synthesis :</b> Routh-Hurwitz stability criteria, Hurwitz polynomial, its properties , positive real function (p.r.f), properties and testing of p.r.f, synthesis of driving point and transfer functions of passive networks in Foster and Cauer forms.	5
		201 127

- Networks and Systems, D. Roy Choudhury, 2<sup>nd</sup> Edition, 2013, New Age International, ISBN 10: <u>8122427677</u>/ISBN13:9788122427677
- 2. Circuits and Systems, K.M.Soni, 2010, S K KATARIA & SONS, ISBN-10: 8188458066, ISBN-13: 978 -8188458066
- 3. Circuits and Networks, Sukhija and Nagsarkar 2<sup>nd</sup> Edition, 2010, Oxford University Press, ISBN-10: 0198061870 ISBN-13:978-0198061878
- 4. **Network Analysis and Synthesis**, C.L. Wadhwa –3<sup>rd</sup>Edition,2018,NewAge,ISBN-10:9788122420364,ISBN-13:978-8122420364
- Circuit Theory Analysis and Synthesis, A. Chakrabarti 7<sup>th</sup> Edition, 2018, Dhanpat Rai & Co, ISBN-10:8177000004, ISBN-13: 978-8177000009

<u>Reference Books:</u>

- 1. Network Analysis, M.E. Van Valkenburg, 3<sup>rd</sup>Edition, 2015, PearsonEducationIndia, ISBN-10:9789332550131
- 2. Analysis and synthesis of electric circuits, G.Zeveke, 1979, MirPublishers

## **Analog Electronics (EE2203)**

Prerequisites: Semiconductor physics, basic electrical engineering, fundamental so electronics

Weekly c	ontact: 3- 1-0 (L- T-P) Full Marks 100	Credits:4
Module No.	Module Name and Topics	No. of Lecture- Hrs
1.	<b>Semiconductor Junctions:</b> Concept of free electrons and holes in semiconductor, continuity equation, drift and diffusion current, semiconductor p-n junction, current component across semiconductor p-n junction ,p-n junction diode, the volt-ampere characteristic of p-n junction diode, diode resistance, space-charge or transition capacitance, reverse voltage break down, diode rating, few application of diodes, Zenerdiodes and its application,	10
2.	<b>BJTs and FETs:</b> Input and output characteristics of CE BJT amplifier and CS JFET amplifier. Use of BJTs and FETs as amplifier, biasing of amplifiers, h-parameter model and Hybrid-pi model of BJTs, model of FETs, frequency response of the amplifiers, coupling of multistage amplifier, high input impedance amplifier :boots trapping ,Darling ton combination.	10
3.	<b>Feedback amplifiers and Oscillators:</b> Different feedback configurations. Use of negative feedback, Analysis of amplifier circuit using feedback concept, Use of positive feedback: Theory of sinusoidal oscillator –The Barkhausen criteria. Application, Multi-vibrators: a stable, mono-stable, bi-stable multi-vibrators	7
4.	<b>Difference Amplifier:</b> Common mode and differential mode gains, CMRR. Realization of DIFF amplifier using BJT and FET and their difference mode and common mode gain. Internal circuit of a typical OPAMP (analysis); drift, offset. Buffers, Adders, subtractors, differentiators, integrators using OPAMPs.	7
5.	<b>Special Applications of OPAMPs:</b> Oscillators–Wien Bridge, Phase-Shift, and Quadrature; V-f and f-V, PLL, Triangle & Saw-tooth wave form generator circuits. 555 I C and its applications, Schematics and Principles; Comparators–ZCD, with Hysteresis	5
	Total:	39L+13T

#### Text Books:

- 1. **Microelectronic Circuits–Theory and Applications**–A.S Sedra and K.C.Smith, Oxford UniversityPress,7<sup>th</sup> Edition, South Asia Edition, ISBN:9780199476299
- 2. Electronic Devices and Circuits (Discrete and integrated) Y.N.Bappat, 2<sup>nd</sup>Edition, TataMcGraw-Hill
- 3. **OPAMP and Linear Integrated Circuits-**Ramakant A Gaykward, 4<sup>th</sup>Édition, Prentice Hall, 2000,0132808684,9780132808682
- 4. Electronics Principles-Albert Malvino and David Bates, Eighth Edition, McGraw-HillISBN13:9780073373881

#### **Reference Book:**

- 1. Integrated Electronics: Analog and Digital Circuits and Systems .Millman and Halkias, TataMcGraw-Hill, ISBN 0-07-462245-5
- 2. **Operational Amplifiers**–GBClaytonSteveWinder,Newnes,5<sup>th</sup>Edition,ISBN-13:978-0750659147
- 3. **Design With Operational Amplifiers and Analog Integrated Circuits**–Sergio Franco, Tata McGraw-Hill, ISBN:9780070530447,0070530440
- 4. Design With Operational Amplifiers and Analog Integrated Circuits–Sergio Franco, Tata McGraw-Hill, ISBN:9780070530447,0070530440

Webre sources: https://nptel.ac.in/search for-Analog Circuits

## CONTROL SYSTEMS I (EE2204)

Pre-requisites: Mathematics III, Signals and Systems, Higher Engineering Mathematics

Weekly Contact: 3-1-0(L-T-P)

FullMarks:100

Credits:4

Module No.	Module Name and Topics	No. of Lecture- Hrs
1.	<ul> <li>Introduction:</li> <li>Classification of Dynamic Systems: Continuous/Discrete, Time-invariant/Time-varying, Linear/Nonlinear, Open loop/ Closed loop, Concept of negative feedback, Examples.</li> <li>Transfer Function: Definition, Relation with Impulse Response Function, Order and type of transfer functions, Example : R-L-C series circuit or equivalent.</li> </ul>	2
2.	<b>Representation of Systems:</b> Block diagram algebra, Mason's Gain Formula, Signal Flow graph.	4
3.	Stability: Definition of BIBO and Zero Input Stability, Routh Hurwitz's criterion.	4
4.	<b>Time domain analysis:</b> State Space Modelling of Physical Systems, Solution to State Equations, State Diagrams, State Space to Transfer Function, Linear Transformations.	6
	Transient analysis with Step Input ,Time Domain Specifications, Transient and steady state errors–definitions, Error constants.	4
5.	<b>Frequency domain analysis:</b> Bode plot, Minimum/Non-minimum phase systems, Transportation lag, Pad approximation.	5
	Nyquist stability criterion, Relative stability.	5
	Construction of Root locus.	5
6.	<b>Controllers</b> : P,PI, PD and PID control, Lead and lag compensation(Mention only).	2
7.	<b>Control system components:</b> Synchros, Tachogenerators, A.C. and D.C. Servomotors.	2
	TOTAL:	39L+13T

#### Text Books:

- 1. Control Systems Engineering–N.Nise,6edition, 2010,Wiley India Edition.
- 2. Control Systems Engineering–Nagrath and Gopal ,6<sup>th</sup>Edition, New Age International Publishers.

#### **Reference Books:**

- 1. Modern Control Engineering– K.Ogata, 5<sup>th</sup>Edition,Pearson.
- 2. Automatic Control Systems –B.C.Kuoand F.Golnaraghi,9<sup>th</sup>Edition,Wiley.
- 3. Feedback Control of Dynamic Systems- Franklin, Powell and Naeimi, 5<sup>th</sup>Edition, Pearson.
- 4. NPTEL lecture: <u>https://nptel.ac.in/courses/108101037/</u>

## **Digital Electronics (EE2205)**

#### <u>Prerequisites</u>: Semi conductor physics, Basic electrical engineering, Basics of Electronics

#### Weekly contact:3- 0-0 (L-T- P)

#### FullMarks100

#### Credits:3

Module No.	Module Name and Topics	No. of Lecture- Hrs
1.	<b>Combinational Logic Circuits:</b> Various logic gates and characteristics via truth table and Boolean Algebra; Karnaugh Mapping; SOP, POS; realization; Code Converter, Arithmetic Operations; MUX and DMUX, Encoder/Decoder–ROM & PLA, concept of Schmitt trigger, Tri-state Buffer etc.	9
2.	<b>Latches and Flip-Flops:</b> R-S,D,T,J-K Flip-Flops, state-tables; flip-flops as units of memory and application as contactde-bouncer; Edge and Level Triggered architectures–etc	4
3.	<b>Sequential Logic Circuits:</b> Registers and buffers using flip-flops; Shift-registers and Ring-counters using flip-flops; Serial to Parallel and Parallel to Serial data conversion: Principle and Block diagram; Counters: Up and Down; synchronous and ripple counters; Modulo-N counter – a few examples; design of counter and memory registers, basic binary cell, SRAM and DRAM cells	10
4.	<b>Digital Integrated Circuits</b> BJT characteristics (recap), RTL,DTL and I <sup>2</sup> L circuits; TTL circuits –conventional and open-collector architectures, tri-state TTL architecture, ECL and CMOS circuits	8
5.	<b>Data Acquisition Systems:</b> A to D and D to A conversion, Sample/Hold circuit, Acquisition time, Aperture time, Hold time, Conversion time, Different types of ADCs and DACs	6
6.	<b>Digital Micro-Computer System:</b> Basic Building Blocks of a Digital Micro-Computer System–a brief introduction	2
I	Total:	39L

#### Text Books:

- 1. **Digital Logic and Computer Design,**–M.MorrisMano,1<sup>st</sup>Edition,ISBNNo.:9789332542525,2016
- 2. **Digital Principles and Applications,** Donald P. Leach, Albert Paul Malvino and Gautam Saha ,McGraw Hill Education,8<sup>th</sup> Edition, ISBN No.:978-9339203405,2014
- 3. **Digital Systems: Principles and Applications,** Ronald J. Tocci, Neal S. Widmer and Gregory L. Moss, Pearson, 10<sup>th</sup>Edition, ISBN No.: 978-8131727249,2009

#### **Reference Book:**

- 1. **Microelectronic Circuits Theory and Applications,** A. S. Sedra and K. C. Smith, Oxford, 6<sup>th</sup> Edition, 978-0198089131,2013.
- 2. **Digital Integrated Electronics,** Herbert Taub and Donald Schilling, McGraw-Hill Education, 1<sup>st</sup> Edition,ISBNNo.:978-0070265080,2017.
- 3. Integrated Electronics: Analog and Digital Circuits and Systems, Jacob Milman and Christos C. Halkias, Tata McGraw-Hill Publishing Company Limited, Tata McGraw-Hill Edition 1991, ISBN No.:-0-070462245-5,1999.
- 4. **Electronic Principles,** Albert Malvino and David J. Bates, McGraw-Hill Education, 7<sup>th</sup> Edition, ISBN No.: 978-0070634244,2017.

## **Electrical Machine Laboratory–II (EE2271)**

Class(0-0-3)(L-T-P)

Full Marks -50

Credits:2

Laboratory experiments related to theoretical subjects Electrical Machine-I (EE2102) and Electrical Machines-II (EE2201).

## **Digital Electronics and Analog Electronics Laboratory (EE2272)**

Class(0-0-3)(L-T-P)

Full Marks -50

Credits: 2

Laboratory experiments related to theoretical subjects Digital Electronics (EE2205) and Analog Electronics (EE2203).

## Laboratory on Network Theory(EE2273)

Class(0-0-3)(L-T-P)

Full Marks -50

**Credits:2** 

Laboratory experiments related to theoretical subject Network Theory(EE2202).

## Mini Project-II (EE2291)

#### Class(0-0-0)(L-T-P)

#### **Full Marks-50**

#### Credits:2

**General outline:** Preferably, four to five students should form a group and each such group will have to undertake a ' Mini Project' in the 3<sup>rd</sup> semester which will continue in the4th semester. A single student also may undertake such a project. The aim of such a 'Mini project' is to make the students aware of the concept of a project as beginners. The group/student should select/identify a specific engineering problem out of abroad area of electrical engineering and plan for its execution, employing scientific methods. The methods should have components of analysis/ synthesis/ design/ simulation/ testing etc. towards the solution of the project problem with a focus to complete the project within two semesters. The project should have finite concrete deliverables and conclusions. A project report should be finally submitted at the end of each semester. Additionally, a seminar on the same must be presented by the group/individual at the end of each semester in front of a board of examiners where each student has to present at least a part of the project. On completion of the seminar, each student will have to answer questions asked by the board of examiners on the project undertaken. The evaluation of each student will depend on the work done, report submitted, seminar presentation and the viva-voce examination. The evaluation will test the capability ofa student of working in an individual capacity as well as in a group to plan and execute a project.

#### Specific requirement for Mini project,4<sup>th</sup> Semester:

The work for the 4<sup>th</sup> semester Mini project should start from where it was left in the earlier semester. This semester's work should predominantly include execution of all the remaining planned activities/modules by the end of the semester. Major stress should be given in applying scientific methods of analysis/ synthesis/ design/simulation/ testing etc. for undertaking the activities towards the solution of the project problem. At the end of the 4<sup>th</sup>semester, after end of the work, the final project report should be submitted. It should consist of planning aspects and other important issues reported in the 3<sup>rd</sup> semester and the executing activities undertaken in the 3<sup>rd</sup> and 4<sup>th</sup> semester including components of analysis/ synthesis/ design/ simulation/ testing etc., as applicable, for the particular project including results and deliverables. The project report should be completion its own. Existing books, datasheets, website URL's, research papers etc., as and when consulted for the project work, should be referenced and cited properly in the project report and in the seminar presentation. The project report should end with specific conclusions as on date and the scope for future work. The seminar presentation to be made should point-wise summarize the content written in the project report. Preferably, four to five students should form a group and each such group will have to undertake a 'Mini Project' in the3rdsemester which will continue in the4th semester. A single student also may undertake such a project. The aim of such a' Mini project' is to make the students aware of the concept of a project as beginners. The group/student should select/identify a specific engineering problem out of abroad area of electrical engineering and plan for its execution employing scientific methods. The methods should have components of analysis/ synthesis/ design/ simulation/ testing etc. towards the solution of the project problem with a focus to complete the project with in two semesters. The project should have finite concreted eliverables and conclusions. A project report containing the abovementioned points/elements should be finally submitted at the end of each semester. Additionally, a seminar on the same must be presented by the group/individual at the end of each semester in front of a board of examiners where each student has to present at least a part of the project. On completion of the seminar, each student will have to answer questions asked by the board of examiners on the project undertaken. The evaluation of each student will depend on the work done, report submitted, seminar presentation and the viva-voce examination. The evaluation will test the capability of a student of working in individual capacity as well as in a group to plan and execute a project.

## 5th Semester ( 4years B. Tech (exit) and DD)

Sl. No	Course Name	Course code	Class Load/Week			Credit	Class load/Week (Total)	Marks
			L	Т	Р			
1.	Electrical Machines III (Core Theory-IX)	EE3101	3	1	0	4	4	100
2.	Power System– I (Core Theory-X)	EE3102	3	0	0	3	3	100
3.	Heat Power (Core Theory-XI)	ME3106	3	0	0	3	3	100
4.	Control Systems II (Core Theory-XII)	EE3103	3	1	0	4	4	100
5.	Power Electronics (Core Theory-XIII)	EE3104	3	0	0	3	3	100
	Theory Sub-total		15	2	NIL	17	17	500
6.	Electrical Machines Laboratory-III (Core Lab/Practical-VIII)	EE3171	0	0	3	2	3	50
7.	"Power System Design and Estimation" and "Electrical Machine Design"(Core Lab / Practical-IX)	EE3172	0	0	3	2	3	50
8.	Heat Power Laboratory (Core Lab / Practical-X )	ME3174	0	0	3	2	3	50
	Practical Sub-total		NIL	NIL	9	6	9	150
	5 <sup>th</sup> Semester Total					22	25	650

Kowhe Das (Blattackarya)

6<sup>th</sup> Semester (4 years B.Tech (exit) and DD)

Sl. No	Course Name	Course code	Class Load/Week		Class Load/Week		Class load/ Week (Total)	Marks
			L	Т	Р			
1.	Electric Drives(Core Theory-XIV	EE3201	3	0	0	3	3	100
2.	Power System II (Core Theory-XV)	EE3202	3	0	0	3	3	100
3.	Switchgear and Power System Protection (Core Theory-XVI)	EE3203	3	1	0	4	4	100
4.	Microprocessor and Microcontroller (Core Theory-XVII)	EE3204	3	0	0	3	3	100
5.	Transducers and Instrumentation (Core Theory-XVIII)	EE3205	3	0	0	3	3	100
	Theory Sub-total		15	3	NIL	16	16	500
6.	Power Systems*/ Drives Laboratory/ (Core Lab/Practical-XI)**	EE3271	0	0	3	2	3	50
7.	"Microprocessors and Microcontrollers" and "Transducers And Instrumentation" Laboratory (Core Lab/ Practical-XII)	EE3272	0	0	3	2	3	50
8.	Power Electronics and Control Systems Laboratory (Core Lab/ Practical-XIII)	EE3273	0	0	3	2	3	50
	Practical Sub-total		NIL	NIL	9	6	9	150
	6 <sup>th</sup> Semester Total					22	25	650

\*As per BOAC recommendation ----- Relevant Experiments on HV Engineering shall be offered as a part of PS Lab Expts

for all UG students

\*\* IM with Variable Frequency Drive to show an Energy –Efficient Drive as per BoAC

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## Electrical Machines-III(EE3101)

Prerequisites :(i) Basic Electrical Engineering and(ii) Electrical Machines-I and II at the second year level.WeeklyContact:3-1-0(L-T-P)Full Marks: 100Credits:4

Module. No.	Module Name and Topics	No. of Lecture- hrs
	Construction of Synchronous Machine: Cylindrical and salient pole rotor	3
1	Construction. Damper winding-principle of operation as motor and generator	3
1.	Excitation system including brushless and static excitation system	1
	Phasor Diagrams and Power Flow: Flux-mmf relationship and armature reaction.	
2.	Equivalent circuit. Phasor diagram (cylindrical rotor). Motor and generator action.	5
	Power flow and maximum power, power angle, torque angle	
	Steady state Characteristics: Steady state characteristics (external characteristics,	
3.	field compounding characteristics, frequency, active power, terminal voltage and	5
	reactive power characteristics)	
5	V-Curves and Synchronous Condenser: Effect of varying field excitation and V	4
5.	curves. Synchronous condenser and its application	
	<b>Determination of parameters:</b> Determination of parameters of synchronous	
6.	machine, Tests for the same, Separation of Xs into armature reaction and leakage	2
	Reactance components	
7.	Voltage regulation: Short circuit ratio and its significance. Determination of	3
	Voltage regulation by different methods	
8	Steady state analysis of Salient pole machine: I we reaction theory and phasor	2
0.	Operation and Controls Excitation and neuron similar synchronizing neuron	
9.	Parallel operation of alternators, methods of synchronization	5
	Starting methods · Droblems during starting and methods of starting Synchronous	
10	induction motor (Mention only) principle of starting with position feedback (and	2
10.	self-synchronous or self-control concepts	3
	<b>Other type of synchronous motors:</b> Singly excited doubly salient machines –	
	variable reluctance Stepper motor, universal motor. Synchronous reluctance	4
11.	machines, SRM	-
	Standards and codes : National/International Standards and codes of Synchronous	
12.	machines (discuss at least one)	2
	Total:	39L+13T

Text Books:

- 1. **The Performance and design of Alternating Current Machines,**M.G.Say–3<sup>rd</sup>Edition,2002,CBSPublishers,NewDelhi.
- 2. **Electrical Machines**, P.S. Bimbhra–7<sup>th</sup>Edition, 2011, KhannaPublishers, NewDelhi
- 3. **The performance and design of AC Commutator motors,** Open shawTaylor .1<sup>st</sup>Edition,1958,Pitman,London.
- 4. Theory of AC Machinery, A.S.Langsdorf– 2ndRevised Edition, 1984, McGrawHillEducation, Noida.
- 5. Electric Machines, S.K. Sen-4<sup>th</sup>Edition, 1977, KhannaPublishers, NewDelhi
- 6. **A Course in Electrical Engineering, Vol-II**, Chester L. Dawes— 1<sup>st</sup> Edition, 1922, McGraw-Hill Book Company, NewYork
- 7. **Design and analysis of Electric Machines**, Kostenko and Piotrovsky-;2<sup>nd</sup>Edition,1969,Mir Publishers
- 8. Theory of AC Machines, PuchsteinandLlyod–2<sup>nd</sup>Edition,1942,JohnWileyand Sons,NewYork
- 9. **Electric Machinery**, Fitzgerald &Kingsley–6<sup>th</sup>Edition,2017,McGrawHillEducation

Kowhe Das (Blattacharya)

### **Power System-I(EE3102)**

#### Prerequisite: 1.Basic Electrical Engineering 2.Electrical Machines I

WeeklyC	ontact:3–0–0(L–T–P) Full Marks: 100	Credits:3
Modul e No	Course Content	No of Lectur e-Hrs
1.	<b>Basic Concepts:</b> -Structure of Power Systems, Fundamental aspects of Thermal ,Hydel, Nuclear and Gas-fired power generating stations, Renewable energy generation methods, Distributed generations, Introduction to transmission and distribution aspects of electrical power, Voltage levels, Mesh and Radial Systems, Concept of Grid and Micro-grid.	8
2.	<b>Per-unit method:</b> –Per unit system, Concept of base parameter sand perunit parameters, Calculation of Per-unit impedance, change of base, Advantages of p.u. method.	3
3.	<b>Transmission line Parameters:</b> - Overhead line inductance and capacitance, flux linkage due to internal flux, flux linkage due to flux between two external conductors, $1-\phi$ and $3-\phi$ inductance and capacitance calculation (symmetrical and unsymmetrical spacing), composite conductors, configuration of bundled conductors, Skin and Proximity effect, Transposition ,Double circuit line, Interference.	4
4.	<b>Performance of Transmission lines:</b> –Short, medium, and long line, ABCD constants, Voltage regulation, Ferranti effect, Power flow through line, Surge Impedance Loading, Power circle diagram, P- $\delta$ and Q-V coupling, Reactive power compensation, St. Clair's Curve (load ability).	4
5.	Mechanical Design of Overhead Line:– Poles and towers, Calculation of sag, effect of ice and wind loading, Stringing chart, Sag template, Vibration damper, Arcinghorn.	3
6.	<b>Power cables:</b> – Types and classification, Insulating materials, Conductor materials, Dielectric stress, Inters heath and capacitance grading, Power factors of cables, Heating and causes of breakdown, Cable laying and Joining, Cable selection, Power factor of cables ,Cable capacitance and Cable testing	4
7.	<b>Over head line insulators and Corona:</b> -Types, Voltage distribution, String efficiency, Methods of equalizing potential, Insulator failure, Corona-its formation, Critical voltage, Corona loss and its reduction.	3
8.	<b>P-f and Q–V control</b> :– Concepts, Power-frequency (P-f) and Reactive Power-Voltage(Q-V) control mechanisms.	3
9.	<b>Symmetrical faults:</b> –Three phase short circuiton loaded and unloaded alternator, Calculation of short circuit kVA.	4
10.	<b>Power system grounding:</b> –Objective of Neutral grounding ,Difference between grounded and ungrounded system, Different methods of grounding, Grounding transformer, Equipment grounding.	3
	Total	39L

#### Text Books:

- 1. **Power System Analysis** ,Graingerand Stevenson,1<sup>st</sup>Edition,2010, Mc Graw Hill Education,ISBN-10:9780070585157
- 2. **Power System Engineering**, Kothari and Nagrath, 2008, Tata McGraw Hill Education, ISBN0070647917,9780070647916
- 3. **Power System Analysis and Design**, Glover, Sarma and Overbye, 5<sup>th</sup> edition, 2012, Cengage Learning India Private Limited,ISBN-10: 9788131516355,ISBN-13:978-8131516355
- 4. **Power System Analysis**, Bergen and Vittal, 2<sup>nd</sup> edition, 2000,Prentice Hall, ISBN0136919901,9780136919902
- 5. **Power System Analysis Operation and Control**, Chakrabarti and Halder, 3<sup>rd</sup> edition, 2020,PHI LearningPvt.Ltd,ISBN-10: 8120340159,ISBN-13:978-8120340152

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## **CONTROL SYSTEM-II(EE3103)**

## Prerequisites: Control Systems-I

WeeklyContact:3-1-0(L-T-P)

## Full Marks: 100 Credits:4

SI.	Module Name and Topics	No. of
No.		Lecture-
		hrs
1.	State Variable Control: Controllability, Linear State Variable Feedback Control,	
	Observability, Observers.	10
2.	<b>Discrete Time Systems:</b> Sampled-data systems; Overview of computer controlled systems; z- transform for discrete time signals and systems; Examples of z-domain transfer functions; Stability and response; Frequency spectrum and Sampling theorem; Aliasing effect and its remedy; Design of digital controllers.	11
3.	<b>Control Systems Design:</b> Design of Lag, Lead and Lag/Lead compensators. Design of PI and PD controllers, Case studies.	
		10
4.	Introduction to Non linear Control: Phase Plane Analysis, Lyapunov Stability.	
		04
5.	<b>Introduction to Optimal Control Systems:</b> Performance Index, Examples, Linear Quadratic Regulator.	04
	TOTAL:	39L+13T

#### Text Books:

- Control Systems Engineering, N.Nise,6<sup>th</sup>edition,2010,WileyIndiaEdition.
   Modern Control Engineering, K.Ogata,5<sup>th</sup>Edition,Pearson
- 3. Control Systems Engineering, Nagrath and Gopal,6<sup>th</sup>Edition,New Age International Publishers.
- 4. Automatic Control Systems, B.C.Kuo and F. Golnaraghi, 9<sup>th</sup>Edition, Wiley
- 5. Feedback Control of Dynamic Systems Franklin ,Powell and Naeimi,5<sup>th</sup>Edition,Pearson

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## **Power Electronics (EE3104)**

Prerequisite: Analog Electronics

Veeklyco	ntact:3 – 0–0 (L-T-P) FullMarks-100	Credits:3
Module No.	Module Name and topics	No. of Lecture Hrs
1.	<b>Solid State Devices for Power Control:</b> Power Diodes-construction and switching characteristics. Four layer devices like – SCR, GTO, IGCT etc. – their operation and switching characteristics, Isolations and synchronization of driving pulses, Triggering and commutation scheme of SCR. BJT's, Power MOSFET's &IGBT's – their drive circuits, static and dynamic characteristics. Requirement and design of switching aid circuits.	6
2.	<b>Uncontrolled &amp; Controlled Rectifier circuits (single phase and three phase)</b> – voltage output ,power output, Transformer Utilization Factor ,Ripple Factor, Power Factor. Selection of rating of devices. Use of freewheeling Diodes. Effects of source and load inductances. Control strategies. Filter requirement.	7
3.	AC Voltage Controller(single phase only):Integral cycle control, phase control, their applications-transformer tap changer	2
4.	DC/DC Converters –Classifications, principles, design, analysis and uses	5
5.	<b>Inverters</b> – Principles and different topologies of single phase and three phase bridge and PWM inverters. Commutation process for thyristorised inverters. Selection of circuit parameters, method of voltage and frequency control, reduction of harmonics, VSI & CSI.	6
6.	Cyclo converter-Principle, types, single and three phase circuits, uses	3
7.	Power Supplies–Principles, different topologies and uses of SMPS,UPS	3
8.	<b>Industrial Applications: DC Drives</b> : Speed Control of dc motors using power circuits. Steady state and transient analysis of open loop and close loop controlled DC motor using converters/choppers.	4
9.	AC Drives–Stator voltage control and PWM Control of three phase induction motors. Closed loop control principles and blocked schematics.	3
	Total:	39L

Text Books:

- 1. **Power Electronics-Circuits, Devices and Applications**,byM.H.Rashid;4<sup>th</sup>Edition,2014,PrenticeHall
- 2. Thyri storised Power Converters by G.K.Dubeyetal.,1986,New Age International
- 3. **Power Electronics: Converters, Applications and Design** by N.Mohan, T.M.Undeland and W.P.Robbins;3<sup>rd</sup> Edition, 2002,JohnWiley&Sons.
- 4. **Power Electronics** byC.W.Lander;3<sup>rd</sup>Edition,1993,McGrowHill.
- 5. **Power Electronics** by P.S.Bhimra; 1990, Khanna Publishers

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## Laboratory and Practical Electrical Machine Lab-III(EE3171)

Class(0-0-3)(L-T-P)

Full Marks -50

Credits:2

Laboratory experiments related to theoretical subject Electrical Machine-I (EE2102), Electrical Machine-II(EE2201)and Electrical Machine-III (EE3101)

## "Power System Design and Estimation" and "Electrical Machine Design" (EE3172)

Class(0-0-3)(L-T-P)

Full Marks -50

Credits:2

#### Power System Design and Estimation is based on the following topics:

Determination of transformer capacity, determination of short circuit impedance and overload capacity of the transformer following national/international standards, determination of voltage regulation, validation of transformer sizing under various loading/contingency conditions, validation of the design using programming technique.

Design of electrical power system for Hospital/Commercial building

Determination of practical line load ability and voltage regulation of a long compensated/uncompensated transmission line, selection of transmission line voltage and estimation of number of lines for power transfer. Validation of design using programming technique

Design of Lightning protection of High rise

building Design of Sub-Station Grounding

Material

## Any one of (i)and (ii) and any one of (iii),(iv) and(v)will be considered for a particular semester

#### **Electrical Machine Design is based on the following topics:**

Design of Transformer (1 phase and 3 phase): Construction, Main dimensions, Core design, Winding design, Magnetic circuit and leakage reactance calculations, Performance calculation, Design of tank, cooling tubes, radiators and conservators, Design considerations for protection against surge, Transformer accessories.

Design of 3 Phase Induction Motor: Main Dimensions, Design of windings and slots, Squirrel cage motor bars and end rings, Selection of slot combination, Calculation of equivalent circuit parameters and performance characteristics, Calculation of temperature rise, Design of shaft.

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## Electric Drives (EE3201)

#### Prerequisite: Electrical Machines -I, II and III and Power Electronics

Veekly co	ntact:3- 0- 0 (L-T-P) FullMarks-100	Credits:3
Module No.	Module Name and topics	No. of Lecture- hrs
01.	<b>Concept of drives:</b> Group drives, multi-motor drives, direct drives. Drive specifications. Four quadrant representations, dynamics of loading of motors with Different types of load. Constant torque drive and constant power drive.	4
02.	<b>Solid state control of DC motors:</b> Basic principles. Drive schemes with armature voltage feedback and IR-compensations together with tacho feedback for both constant flux and field weakening. Modelling of the DC power converter system.	5
03.	<b>Solid state control of AC motors:</b> Basic principles. Drive schemes with stator voltage control. V/f control with constant flux and field weakening with and without tacho feedback, slip compensation. Vector control of induction machine, direct torque and flux control. Modeling of different AC converter system. Solid state control of synchronous motors.	10
04.	Motor Control components: DOL starters, contactors, limit switches, relays etc.	2
05.	<b>Power electronic control of starting of DC and AC motors:</b> Accelerating time, energy loss in starting. Effect of flywheels. Realization of the total converter system of A C and DC ives.	6
06.	<b>Braking:</b> Dynamic braking, regenerative braking, DC injection, plugging. Protection schemes for overall drive systems. Transient time and energy loss during transient process.	4
07.	Heating and cooling of motors : operating duty cycles. Enclosures of motors. Selection of motor rating. Choice of coupling and bearings.	5
08.	<b>Drives for Specific Applications:</b> Drive Considerations for Textile Mills, Steel Rolling Mills, Cranes and Hoist Drives. Cement Mills, Machine Tools, Paper Mills, Coal Mines. Centrifugal Pumps etc.	3
	Total:	39L

Text Books:

- 1. Fundamentals of Electrical Drives, G.K. Dubey; 2003, Narosa Publishing House,
- 2. Electric Drives, N.K.DeandP.K.Sen;2001,Prentice Hall of India Ltd.,
- 3. Modern Power Electronics and AC Drives, B.K.Bose:2003,PearsonEducation
- 4. **Power Electronics: Converters. Applications and Design**. N.Mohan. T.M. Undeland.and W.P.Robbins:Ed.,2003,JohnWiley&Sons.
- 5. Power Electronics-Circuits, DevicesandApplications, M.H.Rashid3rdEd., 2004, PrenticeHall.

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#### Power System–II (EE3202)

#### Prerequisite:1.Power System-I, Electrical Machines I and II

Weekly Co	ntact:3–0–0(L–T–P) Full Marks:100	Credits:3
Module No.	Course Contents	Noof Lecture- Hrs
1.	<b><u>EHV AC and HVDC transmission systems</u></b> – Introduction to AC and DC Power Transmission, Aspects of EHV AC Power transmission, Comparison of AC and DC Power transmission, HVDC systems –terminal equipments, power flow through DC links, control of power, HVDC protection system.	4
2.	<b>Power flow analysis</b> – Formation of bus admittance matrix, real and reactive power balance equations at a node, bus specifications, Gauss-Seidel, Newton-Raphson, First-Decoupled and DC load flow methods, solutions of non-linear equations and application of numerical methods, Sparse matrix, computational issues in large power systems, basic aspects of Contingency analysis.	5
3.	<u>Analysis of faults in power systems</u> – Symmetrical and unsymmetrical faults, Step by step method of formation of ZBUS, symmetrical components – Fortescue's Theorem, Sequence impedance, Positive, negative and zero sequence networks, Un symmetrical faults–single line to ground, line to line, double line to ground	5
4.	<b><u>Power system transients</u></b> –Lightning and switching surges, Travelling wave, Bewley's Lattice diagram, Basic Insulation level, Protection of systems and equipments against over voltage, Insulation co-ordination.	4
5.	<b>Fundamental aspects of power system. stability</b> - Steady State and Transients ability, Equal area criteria, Critical clearing time and angle, Swing equation and its solution, Factors affecting stability, Improvement of stability, Aspects of voltage stability.	5
6.	<b>Fuses and Circuit breaker</b> –Basic function of fuse operation, HRC fuse, Fuse application, circuit breaking mechanism during fault, Arc quenching mechanism, Types of circuit breakers, Current chopping, Arc Chute and Pre-Insertion resistors, Isolators, Rating of circuit breakers, Selection of Circuit breakers for each location and voltage rating, Coordination of fuses and circuit breakers.	5
7.	<b>Power System economics and management</b> – Interconnected system, Its advantages, Distribution of load between thermal units within a plant, Economic operation with and without transmission losses considered, concept of power exchange and spot pricing, Deregulation and management.	5
8.	<b>Fundamental aspects of Power system protection</b> – Basic function, Elements in protective scheme –CT, PT, CVT connections, Types of relay, Electromagnetic induction and attraction type relay, Over-current, Over voltage, Concepts of Directional And Non-directional over-current relay, Static and Numeric Relays.	6
	Total	39L

Text Books:

- 1. **Power System Analysis**, Grainger and Stevenson, 1<sup>st</sup> Edition, 2010, McGraw Hill Education, ISBN-10:9780070585157
- 2. **Power System Analysis**, Bergen and Vittal, 2<sup>nd</sup> edition, 2000,Prentice Hall, ISBN0136919901,9780136919902
- 3. **Power System Engineering**, Kothari and Nagrath, 2008, Tata McGraw Hill Education, ISBN 0070647917, 9780070647916
- 4. **Power System Analysis Operation and Control**, Chakrabarti and Halder, 3<sup>rd</sup> edition, 2020,PHI LearningPvt.Ltd,ISBN-10: 8120340159,ISBN-13:978-8120340152
- 5. Power System Stability and Control, P S Kundur, Mc graw hill HED, ISBN: 9780070635159, 9780070635159
- 6. **Electric Power Systems**, Weedy, Cory, Jenkins Ekanayake, Strbse5<sup>th</sup>Edition, 2012, WileyISBN-10:047068268X, ISBN-13:978-0470682685,

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## Switchgear and Power System Protection (EE3203)

**Prerequisite:** Fundamentals of Electrical Machines and Power Systems

Weekly con	tact:3-1 -0 (L-T- P) Full Marks- 100 C	redits:4
Module No.	Module Name and topics	No. of lecture- hrs
1.	<b>Switchgear:</b> Basic functions of a circuit breaker. Basic principle of operation. Arc phenomenon, its initiation, maintenance and quenching. Restriking and recovery voltage. Ratings of a circuit breaker and its selection. Different types of circuit breakers – air, oil, vacuum and SF6. Current chopping, breaking of capacitive current. DC circuit breaking	7
2.	<b>Basic Principle of protective relaying:</b> Basic function of relay, its attributes and categorisation. Magnitude relay, Directional relay, Differential relay, Fundamentals of Numerical Relaying	6
3.	<b>Transmission Line protection :</b> Distance Relaying and Pilot Relaying, Ordinary Impedance, Modified Impedance, Angle Impedance, Mho, Quadrilateral Relay; Reach, Over Reach, Under Reach of an impedance relay; Three step time lag distance Rely; Wire Pilot, Carrier Pilot and micro-wave pilot	6
4.	Generator Protection: Stator faults, Rotor faults, Abnormal operating conditions-unbalanced loading, loss of excitation, prime-mover failure	5
5.	<b>Transformer Protection:</b> Percentage Differential Relay, Inrush Phenomenon and Over-fluxing Phenomenon, Percentage Differential Relay with harmonic restrain, Incipient faults, Buchholz Relay and analysis of trapped gases	4
6.	<b>Bus bar protection and substation automation</b> : Differential Protection, IED, IEC protocols	3
8.	Motor Protection: Electrical faults, Mechanical faults and Abnormal Operating conditions in supply side-Unbalanced supply, Single phasing, low voltage	2
9.	Capacitor Bank and Reactor Protection: Short circuit, Over current, Differential and Earth Fault Protection	2
10.	Recent Developments: Digital Protection algorithms, System Protection	4
	Total	39L+13T

### Text Books:

- 1. **Fundamentals of Power System Protection**, Pathinkar, Y.G. and Bhide, S.R., (2008)., PHI Learning Pvt. Limited.
- 2. **Protective Relaying Theory and Applications**, Elmore, W.A., (2003)., ABBPowerTandDCompanyInc.
- 3. **Power System Protection and Switchgear**, Badri Ram,B.H.Vishwakarma,\_, Second Edition 2011,New Age International Pvt Ltd Publishers.
- 4. **Protection and Switchgea**r, Bhavesh Bhalja, R.P.Maheshwari, NileshG.Chotani, 2011, Oxford University Press.

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### Micro processors and Micro controller (EE3204)

Prerequisite: Knowledge of Digital Electronics

Weekly co	ntact:3–0 –0(L – T–P) FullMarks:100	Credit: 3
Module No.	Module Name and Topics	No. of Lecture- hrs
1.	Evolution of microprocessor-4004 to Pentium-Advancement parameters	2
2.	Number system: Brief discussion on number systems and representation of	2
	fixed/floating point numbers in a microprocessor, BUS and system concept	
3.	Organization and Architectural Features of 8bitprocessor:8-bit processor	11
	(Intel8085)[including addressing modes, Machine Cycle and Timing, BUS	
	Arbitration etc.], Instruction set and Programming; its drawbacks	
4.	Brief Organization and Architectural Features of 16-bit and 32-	5
	bitprocessors -Intel8086, 80286, 80486, Pentium	
5.	Organization and Architectural Features of an 8-bit	11
	microcontroller:Intel8051 [including addressing modes, timing diagram etc.],	
	Instruction set and Programming; Brief mention of PIC/ ARM/ ATMEGA	
6.	Interfacing: Interfacing with data ports, timers, interrupt controllers, data	8
	converters etc. Introduction to USART, RS-232C, USB, DMA.	
	Total:	39L

#### <u>Text books</u>

- 1. **Microprocessor Architecture, Programming ,and Applications with the 8085**:Ramesh S.Gaonkar,5<sup>th</sup>Edition,2002 Prentice Hall Series, Pearson.
- **2.** The8051Microcontroller:K.Ayala, 3<sup>rd</sup>Edition,2007,ThomsonDelmar Learning, Cengage *Reference books:* 
  - 1. The Intel Microprocessors: 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, Pentium Pro, and Pentium II Processors: Architecture, Programming ,and Interfacing ,Barry B.Brey, Prentice Hall ,imprint 2005, Pearson Education, ISBN9788131726228
  - 2. Micro processors and Interfacing: Programming and Hardware. Douglas V. Hall, 2<sup>nd</sup> Edition, 1991, Tata Mc Graw Hill
  - 3. The 8051 Microcontroller and Embedded Systems Using Assembly And C (2/E), Mazidi, 2007, Pearson Education
  - 4. Advanced Micro processors and Peripherals, Ray and Bhurchandi, 2006, TataMcGrawHill
  - 5. **Microprocessors and Interfacing 8086, 8051, 8096, and Advanced Processors**, Senthil Kumar, 2012, OxfordHED
  - 6. **Microprocessors and Micro controllers** ,N. Senthil Kumar, M. Saravanan, S. Jeevananthan, 2010, Oxford University Press

#### Webresource:

1. NPTEL video course -https://nptel.ac.in/courses/108105102/

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## **Transducers and Instrumentation (EE3205)**

**Prerequisites: Analog Electronics and Digital Electronics** 

	WeeklyContact:3-0-0(L-T-P) FullMarks:100 Credits: 3	
Module No.	Module Name and Topics	No. of Lecture- hrs
1.	<b>Introduction</b> : To instrumentation systems and its operation. Performance Characteristics – Static and Dynamic; Order of the instrumentation systems. Signal standards, Live and dead zero.	2
2.	<b>Sensors and Transducers</b> : Classifications, Transducers for measurement of non- electrical quantities: displacement, level, strain, pressure, force, torque, temperature, flow, velocity, acceleration, speed, etc.; seismic measurements. Transducers for measuring Electrical quantities.	6
3.	<b>Special Transducers</b> : Piezo-electric transducers, pH sensors ,Electro-analytic transducers, Radioactive transducers.	4
4.	Direct Digital Transducers : position encoders, speed counters etc.	2
5.	Instrumentation amplifiers:	4
6.	<b>Signal Generators</b> : Diode Function Generator, Triangle, Saw-toot hand Staircase wave form generator.	2
7.	<b>Signal conditioners:</b> Level shifters, voltage to current, current to voltage converter; Peak detectors, Sample/Hold circuit, linearizers.	2
8.	<b>Signal Processors:</b> Window Comparators, Absolute value circuits, Precision rectifiers; Log- and Antilog- amplifiers – multiplier, divider, squarer, square rooter, RMS converter and True RMS circuits. F to V and V to F converters.	5
9.	<b>Data Acquisition System and Central monitoring</b> : Single and multichannel data acquisition; Analog and digital display devices, Data loggers, Recorders, Plotters, Application of microprocessors in Instrumentation System.	5
10.	<b>Programmable Logic Controllers:</b> Block diagram, operating sequence, input-output specifications and standards, response timings; Ladder diagram, programming; Simple problems.	3
11.	<b>Signal transmission and Telemetry systems</b> : Analog and Digital data transmission, voltage and current standards; p-i, i-p converters, modulators and demodulators, RZ, NRZ signals.	3
12.	Typical case studies and related modern topics.	1
	Total:	39L

Text Books:

- **1.** Measurement System, E.O.Doebelin,5<sup>th</sup>Edition,2003,McGrawHill.
- 2. Transducers & Instrumentation, D.V.S.Murthy, 2<sup>nd</sup>Edition, PHI.ISBN:9788120335691
- **3.** Electronic Measurements and Instrumentation ,H.S.Kalsi, 3<sup>rd</sup>Edition, 2012, TataMcGrawHill.
- 4. Instrumentation: Devices and Systems ,Rangan, Sarma and Mani,2<sup>nd</sup>Edition,2017,TataMcGrawHill.
- **5. Programmable Logic controllers and Industrial Automation-an Introduction,** Mitra and Sengupta, 2<sup>nd</sup>Edition, 2017, Penram.
- 6. Telemetry Principles D.Patranabis,1999,TataMcGrawHill.

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## **Practical/Laboratory Subjects**

## **Power Systems and Drives Laboratory (EE3271)**

Class(0-0-3)(L-T-P)

Full Marks -50

Credits: 2

Laboratory experiments related to theoretical subjects "Power System-II" (EE3202) and" Electric Drives" (EE3201).

## <u>"Micro processors and Micro controllers "and" Transducers and Instrumentation"</u> <u>Laboratory EE3272</u>)

Class(0-0-3)(L-T-P)

Full Marks -50 Credits: 2

Laboratory experiments related to theoretical subjects "Microprocessors and Micro controllers" (EE3204) and "Transducers and Instrumentation" (EE3205).

## **Power Electronics and Control Systems Laboratory(EE3273)**

Class(0-0-3)(L-T-P)

Full Marks -50

Credits: 2

Laboratory experiments related to theoretical subjects "Power Electronics" (EE3104) and "Control Systems-I and Control System-II" (EE2204 and EE3103).

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## 7<sup>th</sup> Semester(4 years B.Tech(exit))

Sl. No	Course Name	Course code	Class	Class Load/Week		Credit	Class load /Week (Total)	Marks
			L	Т	Р			
1.	Digital Signal Processing and Embedded System (Core Theory-XIX)	EE4101	3	0	0	3	3	100
2.	Electrical Energy Utilization and Grid Interactive Control (Core Theory - XX)	EE4102	3	0	0	3	3	100
3.	Core Elective – I	EE4121 /22/23/24	3	1	0	*	3+1	100
4.	Finance ECO and Management for Engineers	HU4101	3	0	0	3	3	100
	Theory Sub-total		12	0	0	13	13	400
5	Laboratory on "Digital Signal Processing and Embedded System"	EE 4171	0	0	3	2	3	50
6.	Switch gear and Power System Protection Laboratory ( Core Lab/ Practical-XV	EE4172	0	0	3	2	3	50
7.	B.Tech Project/Part-1	EE4191	0	0	2	4	2	100
8.	Internship(Evaluation)	EE4192	0	0	0	2	0	50
	Practical Sub-total		NIL	NIL	8	10	8	250
	7 <sup>th</sup> Semester Total					23	21	650

**\*Decision pending** 

**Core Elective-I :** 

1. High Voltage Engineering (EE4121)

2. New and Renewable Energy (EE4122)

**3. Illumination Engineering (EE4123)** 

4. Soft Computing and Intelligent System (EE4124)

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## 8th Semester(4 years B.Tech (exit))

Sl. No	Course Name	Course code	Cla	Class Load/Week		Credit	Class load/Week (Total)	Marks
			L	Т	Р			
1.	Power System Planning and Reliability(Core Theory-XX)	EE4201	3	1	0	4	4	100
2.	Core Elective– II	EE4221 /22/23	3	0	0	3	3	100
3.	<b>Open–Elective II*</b>		3	0	0	3	3	100
	Theory Sub-total		9	1	0	10	10	300
4.	B.Tech Project Part2	EE4291	0	0	2	8	2	200
5.	Seminar	EE4292	0	0	0	2	0	50
6.	Comprehensive Viva	EE4293	0	0	0	2	0	100
	Practical Sub-total		9	0	2	12	2	350
	8 <sup>th</sup> Semester Total					22	12	650

**Core Elective-II :** 

- 1. Advanced Programming in Electrical Engineering (EE4221)
- 2. Big Data Analytics in Energy Informatics(EE4222)
- 3. Digital Communication in Electrical Systems(EE4223)

#### **Open–Elective II:**

**Electricity Conservation and Environmental Management (EE4261)** 

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## **Digital Signal Processing and Embedded Systems (EE4101)**

**<u>Prerequisite</u>:** Knowledge of micro processors/microcontrollers

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eekly con	tact:3 –0 –0(L – T–P) FullMarks:100	Credits:3
Module No.	Module Name and Topics	No. of Lecture- hrs
1.	<b>Introduction to Digital Signal Processing</b> : LTI systems, step and impulse Responses, convolution; FIR and IIR, recursive and non recursive.	2
2.	<b>Discrete time systems in frequency domain</b> : Discrete Fourier Transform: DFT and FFT algorithms	5
3.	<b>Digital processing of continuous time signals</b> : Introduction to digital filters: Design of II Rand FIR filters, Finite word length effects in digital filters	4
4.	Hardware: Hardware for digital signal processing, DSP chips	2
5.	Introduction to Embedded Systems: Embedded Hardware	2
6.	PIC: Instruction Set, Peripherals on chip	8
	ARM Processor: Instructions, interrupt handling	
7.	<b>System-on-chip:</b> Virtual Memory and Memory Management Unit; Bus structure; Serial interfaces	5
8.	<b>Programmable logic devices:</b> CPLD, FPGA, use of FPGA in real –time simulation	8
9.	Software for embedded systems:	3
	Hardware development languages: VHDL/ Verilog.	
	Total:	39L

#### Text Books:

1. **Discrete Signal Processing,**Oppenheim,SchaferandBuck,3<sup>rd</sup>Edition,2010,PrenticeHall

- 2. PIC Microcontroller and Embedded Systems-Using Assembly and Cf or PIC18 ,Mazidi,2008,PearsonEducation
- 3. ARM System Developer's Guide, Sloss, Symes and Wright, 1<sup>st</sup>Edition, 2004, Elsevier
- 4. **FPGA-based system design**, WayneWolf, 1<sup>st</sup>Edition, 2004, PearsonEducation

#### **Reference books:**

- 1. **Digital Signal Processing,** SanjitK.Mitra, 3<sup>rd</sup>Edition,2008,TataMcGrawHill
- 2. **Digital Signal Processing**, IfeachorandJervis, 2<sup>nd</sup>Edition, 2002, PearsonEducation
- 3. Embedded Systems Building Blocks, Labrosse, 2<sup>nd</sup>Edition, Elsevier
- 4. Programming and Customizing the ARM7 Micro controller, Predko, 2009, McGrawHill
- 5. Modern Embedded Computing, Barry&Crowley, 2012, Morgan Kaufmann
- 6. **AVHDL Primer,** J. Bhasker, 3<sup>rd</sup>Edition,1995,PrenticeHall

#### Web resources:

- 1. NPTEL course on Digital Signal Processing -https://nptel.ac.in/courses/117102060/
- 2. NPTEL course on Embedded Systems-https://nptel.ac.in/courses/108102045/

Kombe Des (Blattackarya)

### **Electrical Energy Utilization and Grid Interactive Control (EE4102)**

Prerequisites: Basic Electrical Engineering, Power Electronics, Control Systems, Electrical Machines I, Electrical Machines II, Electrical Machines III

Weeklyco	ntact: 3–0 –0 (L-T-P) FullMarks-100	Credits:3
Module No.	Module Name and topics	No. of Lecture -hrs
01.	<b>Electric Traction Fundamentals:</b> Traction-System of Track electrification, Train movement and energy consumption (speed- time curves, crest speed, average speed & schedule speed), Tractive effort Factors affecting energy consumption (dead weight, acceleration weight & adhesion weight) Protective devices; Outlining the concept and use of SCADA in railways and Automatic Train Protection Sub-systems(ATP).	6
02.	<b>Electric Traction motor and their control</b> : Electric Traction motor & their control, starting, braking special emphasis on selection of motors, their control and protection; Current collectors in traction, Interference with telecommunication circuit. A brief review of power electronic controllers with respect to traction motors; A brief outline of Linear Induction Motor Principle in Traction.	6
03.	<b>Illumination</b> : Laws of illumination, polar curves, photometry, integrating sphere Types of Lamps, Basic Principles of light Control, Different Lighting Schemes and their Design, Flood-Lighting, Factory-Lighting and street Lighting Lamps, Basic principle of light control, Different lighting scheme and their design Factory, Flood and street lighting.	8
04.	<b>Electric Heating</b> : Electric heating fundamentals, Different important types of heating- arc, induction and dielectric heating, power supplies for such heating	4
05.	<b>Electric Welding :</b> Requirement for good welding, Resistance welding, arc welding, power supplies for different welding.	4
06.	<b>Smart Grid and Micro grids</b> : Introductory concept of Grid and Micro grids: DC and AC, special features of a Micro grid; SCADA /EMS for Energy Management in such Grids;	3
07.	<b>Distributed</b> Generation (DG) and Grid interfacing of DG sources: Concept of energy utilization from distributed generation(DG), issue of AC grid- connectivity of DG sources and role of interfacing converters, converter topologies, maximum power point tracking(MPPT)control	4
08.	<b>Control of Grid-Tied Inverters</b> : Discussion on Schemes of Grid-tie inverter control methodology of three phase inverters based on D-Q rotating reference frame, unit vector generation and role of phase locked loops(PLL),issues of islanding	4
	Total:	39L

#### Suggested readings:

- 1. Utilisation of Electric Energy, Open shaw Taylor, 1971, Orient BlackswanPvt.Ltd.ISBN8125016406, 9788125016403
- **2.** Utilisation of Electric Power and Electric Traction, J.B. Gupta, 10<sup>th</sup> Edition, 2019, S.K. Kataria&SonsISBN978-93-5014-258-5
- 3. Art and Science of Utilisation of Electrical Energy, H. Partab; 2014, DhanpatRai& Co. (Pvt.)Ltd.
- 4. Electric Traction, S.N.Mahendra and J.Upadhyay, Allied Publishers Pvt.Ltd. ISBN: 9788177640052
- 5. Renewable and efficient electric power systems , Gilbert M Masters, 2004, John Wiley &Sons,NewJersey,PrintISBN:9780471280606
- 6. Control of power inverters in renewable energy and smart grid integration, Quing-Chang Zhong and Tomas Hornik, 2012, John Wiley & Sons, IEEE Press 2013, PrintISBN:9780470667095
- 7. Grid Converters for photovoltaic and Wind power systems, Remus Teodorescu, MarcoLissere, P.Rodriguez, 2011, Wiley-IEEE Press, ISBN: 978-0-470-05751-3

Kombe Der (Blettackarge)

## **Core Elective**

## High Voltage Engineering (EE4121)

Prerequisites: Physics , Basic Electrical Engineering, Power System

Weekly c	ontact: 3- 1-0 (L-T-P) FullMarks-100 C	redits: *
Module No.	Module Name and Topics	No. of Lecture- hrs
	<b>Over-voltage Phenomena and Insulation-Coordination</b>	
01.	other causes. Travelling wave theory, reflection and refraction of travelling waves. Protection against over-voltage. Principles of insulation-coordination in high and extra High voltage power systems.	6L
	Break down in Dielectrics Break down in Gases: Gases as insulating media, ionization	
	processes, Townsend's theory of gas break down, Paschen's law, break down in electro negative	
	gases, Streamer theory of break down in gases, break down in non-uniform fields and corona	L
0.2	discharges, vacuum break down.	01
02.	<b>breakdown in Liquids:</b> Liquids as insulators, pure liquids and commercial liquids, conduction and break down in commercial liquids	9L
	<b>Break down in Solid Dielectrics:</b> Solid and composite-dielectrics. Intrinsic break down	1
	Electromechanical breakdown. Thermal Breakdown, breakdown in voids.	
	Generation of High Voltages and Currents AC High Voltage : High voltage Testing	
	Transformer, Cascaded High Voltage Transformer, Resonant Transformer	
	DC High Voltage: Voltage Doubler Circuits, Voltage drop and Regulation, Electrostatic	
03.	Machines for High DC voltage generation–Vande Graaff Generator	9L
	Impulse Voltage: Standard Impulse Wave shapes, Circuits for Producing Impulse Waves,	12
	Wave-shape Control, Multi-stage Impulse Generator – Triggering and Control mechanism	
	Impulse Current: Circuits for producing impulse Current Measurement of High Voltages and Currents High DC Voltages Ammeter with High Series	
	Resistance Resistive Potential Divider Electrostatic Voltmeter	
	<b>High AC and Impulse Voltage:</b> Series Impedance Voltmeter. Capacitive Potential Divider.	
	Capacitive Voltage Transformer(CVT)	07
04.	Peak Voltmeters: Series Capacitor Peak Voltmeter, Peak Voltmeter with Potential	9L
	Dividers, Sphere Gap Measurements.	
	High Currents: Resistive Shunts, Current Transformers	
	High Voltage Testing Non-Destructive Testing: Measurement of Resistance, Measurement of	
	Dielectric Constant and Loss Factor, High Voltage Schering Bridge, Measurement of Large	
05.	Ligh Voltage Testing of Electrical Equipment: High AC DC and Impulse Voltage	6L
	Tests Testing of Insulators Cables Bushing Circuit Breakers Isolators and	
	Transformers	
	Total:	39L+13T

#### **\*Decision pending**

#### Text Books:

- 1. HighVoltageEngineering, M.S.NaiduandV.Kamaraju, 5thEdition, TataMcGraw-HillPublishingCo.Ltd., NewDelhi, 2015, ISBN:9781259062896.
- 2. High Voltage Engineering, C.L. Wadhwa, New Age International Publishers, 3<sup>rd</sup>Edition, ISBN:9788122430905.
- 3. High Voltage Engineering Fundamentals, E.Kuffel and W.S.Zaengl and J.Kuffel, Newnes Publication, Second Edition, 2005, ISBN0750636343.

#### **Reference Book:**

- 1. High-Voltage Engineering: Theory and Practice Mazen Abdel-Salam, Second Edition, CRCPress, 2019, ISBN 9780367398194
- 2. High Voltage Engineering, C.L. Wadhwa, New Age International Publishers, 3<sup>rd</sup>Edition, ISBN: 9788122430905

Kowhe Des (Bletteckarya)

Date: 04/10/2021

## New and Renewable Energy (EE4122)

Prerequisite: Basic Electrical Engineering and Fundament also of Physics and Chemistry

Weekly con	ntact: 3–1–0 (L- T-P) Full Marks-100	Credits: *
Module No.	Module Name and topics	No. of Lecture- Hrs
01.	<b>Introduction:</b> Concept of energy, energy scenario and conversion to electrical form, energy and society, energy and environment, necessity of non-conventional and Renewable energy.	1
02.	<b>Solar energy</b> :Solar radiation and its characteristics, solar Geometry, Measuring solar radiation– Pyrano meter, Pyhelio meter, Sunshine recorder. Green house effects, Solar collector;-flat plate, focusing, water heating-natural circulation, forced circulation, Space heating –active and passive system, solar thermal energy storage, solar pond, Solar power plant.	7
03.	<b>Solar Photo voltaic Conversion</b> : Solar cell-Characteristics, model ,series parallel connection, PV module, PV array, PV system components, types of PV system, concept of Maximum Power Point Tracking(MPPT)	4
04.	<b>Wind energy</b> : Potential, development of wind turbines, wind electric system, wind pump, utilization and national scenario.	6
05.	<b>Microhydelenergy</b> : Potential, development of micro hydro- electric generators & auxiliaries. Non conventional [tidal, wave] hydro electric conversion system	5
06.	<b>Nuclear energy and environment</b> : Review of conventional and nuclear power plant, Nuclear fusion reactor, description of existing models, safety and hazards of nuclear energy.	4
07.	Magneto hydrodynamics energy conversion: Concept, present and future concept, Economic and environmental aspects of MHD generator plant.	3
08.	<b>Bioenergy</b> : Resources and conversion process–biogas conversion biogas plant, present Gas fires and biogas plants used in India, Ocean thermal energy conversion, fuel cell, electric and hybrid vehicles, space vehicles.	4
09	Thermal energy: Ocean thermal energy conversion, Geothermal Energy conversion	1
10	<b>Concept of micro grid</b> : the inter facing of renewable energy micro sources into the micro-grid, the smart grid and its relevance while using renewable energy sources.	3
11	<b>Rural energy security</b> : Hybrid system of renewable energy sources – necessity, Implementation, national policy.	1
	Total:	39L+13T

#### **\*Decision pending**

Text Books:

- 1. **Renewable Energy**, Bent Sorensen, 5<sup>th</sup>edition, AcademicPress, ISBN:9780128045671
- 2. **Renewable Energy Sources and Energy Technology**, Kothari, Singal and Ranjan, 2<sup>nd</sup>edition, Prentice Hall India , ISBN:9788120344709
- 3. **Solar Energy**, S.P.Sukhatme, J.K.Nayak, 4<sup>th</sup>edition, TataMcGraw-Hill, ISBN: 9789352607112

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#### <u>Reference books</u>

- 1. **Renewable Energy Resources**, J. Twidelland T. Weir, 2<sup>nd</sup> Edition, 2005, Taylor and Francis
- 2. **Renewable and efficient electric power systems** ,G.M. Masters, 2<sup>nd</sup> edition, John Wiley and Sons, ISBN:9781118140628
- 3. Renewable energy engineering and Technology. VVN Kishore, 2010, TERI, ISBN 8179932214,9788179932216
- 4. **Bio fuels Engineering Process Technology,** Caye M.Drapcheo, NP Nhuan, T.H Walkar, 1<sup>st</sup>edition, Mc Graw Hill ISBN: 9780071487498
- Bio hydrogen production: Fundamentals and Technology Advantages ,D. Das, N. Khanna , C. Nag, 1<sup>st</sup> edition, CRC Press, ISBN 9781138073203
- 6. **Solar Engineering of Thermal Processes**, J. A. Duffie and W. A. Beckman, 4<sup>th</sup> edition , John Wiley, New York,ISBN:978-0-470-87366-3
- 7. **Principles of Solar Engineering**, D.Y .Goswami, F .KreithandJ. F.Kreider,2<sup>nd</sup>edition, Taylor and Francis, Philadelphia ,ISBN: 978-1560327141
- 8. Biomass Regenerable Energy, D.D. Hall and R.P.Grover, 1987, JohnWiley, NewYork
- 9. Solar Cells, M.A. Green, 1982, Prentice-Hall, Englewood Cliffs.

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#### **Illumination Engineering (EE4123)**

**Prerequisite : Fundamentals of Physics** 

Full Marks-100

Credits: \*

Module No.	Module Name	No. of Lecture- hrs
1.	<b>Sources of light:</b> Day light, artificial light source; energy radiation, visible Spectrum of radiation, black body radiation and full radiator.	5
2.	<b>Production of light:</b> Incandescence, dependence of light upon temperature. Theory of gas discharge.	5
3.	<b>Perception of light and colour:</b> optical system of human eye, eye as visual processor. Reflection, refraction and other behaviors of light. Mesopic Photometry	5
4.	<b>Measurement of light</b> : radio metric and photo metric quantities and the irunits of measurement. Standardization, measurement of light distribution, direct & diffused reflection, fundamental concept of color I meter sand measurement of color.	7
5.	<b>Types of lamps</b> : GLS Tungsten—halogen ,Discharge, low pressures odium vapour, high pressure sodium mercury vapour, fluorescent, Metal-halide IR and UV lamps, their construction, filament material, theory of operation, life , characteristics and application Xenon Lamps, LED lamps, Fiber Optic and Laser Lighting	6
6.	<b>Design of Lighting:</b> Objectives and specification of lighting & system design of luminaire; their electrical circuits and auxiliaries. Basic Lighting Design Considerations and Light in g parameters for interior lighting, exterior lighting and day lighting	4
7.	<b>Other aspects of Lighting:</b> Design and Installation of Lighting Systems, Smart Control and Energy efficient lighting; the physiological effects of lighting,	4
8.	A Case Study with Lighting design Software to learn an optimized design Approach	3
	TOTAL	39L + 13T

\*Decision pending

Weekly contact:3-1-0(L-T-P)

#### Suggested Readings:

- 1. Illuminating Engineering: From Edison's Lamp to the LED, JosephB.Murdoch, VisionsCommunication, ISBN 1885750056, 9781885750051
- 2. **Human Factors in Lighting** ,PeterRobertBoyce,3<sup>rd</sup>Edition, Applied Science Publishers,ISBN0853349126,978085334912
- 3. Road Lighting Fundamentals, Technology and Application, Wout Van Bommel, SpringerPublishers978-3-319-11466-8

#### Web-resource:

- 1. IESNA[www.iesna.org] and CIE[www.cie.co.at] lighting design guidelines/recommendation etc.
- 2. NPTEL Lectures on Illumination Engineering

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## Soft Computing and Intelligent Systems (EE4124)

**Prerequisite: Engineering Mathematics** 

Weekly c	ontact: 3–1–0 (L- T-P) FullMarks-100 Cred	lits: *
Module No.	Module name and topics	No. of Lecture- hrs
1.	<b>Introduction to Intelligent Systems and Soft Computing:</b> Need for intelligent systems and data driven approaches; Inspiration behind soft computing, difference between hard and soft computing, computational	3
	intelligence	
2.	Machine Learning(ML) and Artificial Neural Network(ANN): Introduction to Regression: linear and non linear, Clustering, Classification, learning: supervised, unsupervised and Reinforcement learning, features: feature extraction, feature reduction, data mining, validation; Basics of Neural Computing & Artificial Neural Networks: Major variety of ANN architectures covering Perceptron, MLP,SOM,LVQ with supervised and unsupervised training algorithms; Soft introduction to Convolution Neural Networks (CNN) and Recurrent Neural Networks(RNN)	8
3.	Applications of Artificial Intelligence(AI) and ML: Introduction to Python:, Python basics and Tensor flow; Algorithmic development of intelligent systems with typical examples in electrical engineering	8
4.	<b>Fuzzy Systems and its Applications:</b> Basic concepts of Fuzzy logic approaches, linguistic variables, membership functions, basic operation, Fuzzy relations, different de-Fuzzification techniques, Fuzzy rule based model, type-2 Fuzzy system, Intelligent Systems and fuzzy logic controllers	6
6.	<b>Evolutionary Algorithms</b> : Introduction to search optimization method, evolutionary algorithms(EA) Genetic algorithms(GA): biological inspiration behind GA, working principles, encoding, crossover and mutation, basic GA algorithm Particle Swam Optimization (PSO): Natural inspiration of Swarm intelligence, ring topology, star topology	6
7.	Applications of Evolutionary Optimization Techniques Development of GA and PSO based algorithm sin typical electrical engineering applications	4
8.	<b>Hybrid Intelligent System:</b> Neuro-fuzzy, ANN-EA, Fuzzy-EA based inference systems, advantages and applications	4
	TOTAL	39L + 13T

#### \*Decision pending

Text Books:

- 1. Neural Networks and Learning Machines, Simon Haykin, 2019, Pearson,
- 2. **Behavioral and Cognitive Modeling of Human Brain**, A.Konar, Artificial Intelligence and Soft Computing:, 2000, CRC press
- 3. Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis And Applications, S. Rajasekaran and G.A. Vijaya lakshmi Pai, 2003, PHIL earning Ltd,
- 4. Soft Computing: Techniques and is Applications in Electrical Engineering, D.K.Chaturvedi, 2008, Springer
- 5. Optimization for Engineering Design: Algorithms and Examples K.Deb,2012,PHI,

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## **Laboratory** /Practical

## Laboratory on "Digital Signal Processing and Embedded System" (EE4171)

Class(0-0-3)(L-T-P)

Full Marks -50

Credits:2

Laboratory experiments related to theoretical subjects "Digital Signal Processing and Embedded System" (EE4101)

## Switch gear and Power System Protection Lab (EE4172)

Class(0-0-3)(L-T-P)

Full Marks -50

Credits:2

Laboratory experiments related to theoretical subject "Switch gear and Power System Protection" (EE3203).

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#### **B. Tech Project Part-1(EE4191)**

Full Marks -100

Weekly contact (0-0-2) (L-T-P)

Each candidate or a group will be assigned a problem related to Electrical Engineering on which the candidate(s) will carry out preliminary work with literature review/study and/or analysis. The candidate will submit a brief report and present the project-work, and appear for viva-voce at the end of semester.

#### **Internship Evaluation (EE4192)**

#### Weekly contact (0-0-0)(L-T-P)

FullMarks-50

#### **Credits-2**

**Credits-4** 

The student shall have to submit a report on the internship program(academic/ industrial work/ project/assignments) that the student this performed at the end of the SIXTH semester in any institute/organization along with a copy of participation/endorsement certificate from the host institute/organization, within one month from the commencement of the SEVENTH semester. The student as an individual or in a small group shall have to present their internship performance before a board of examiners duly constituted by the electrical Engineering Department for assessment. The seminar assessment may be done some time just before or after the mid-term examination of the SEVENTH semester.

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# Power System Planning and Reliability(EE4201) Prerequisite: Probability theory & Power system-II

Weekly o	contact (3-1-0)(L-T-P) Full Marks- 100	Credits:4
Model	Module Name and Topics	No. of
No.		Lecture-hrs
1.	Introduction	2
	Basic planning and project planning, Tools and techniques for power system planning	
2.	Load Forecasting	8
	Objectives of power system load forecasting, load forecasting categories — long term,	
	medium term and short term, Characteristics of loads, forecasting methodology,	
	extrapolation technique to fit trend curves to basic historical data, simple regression and	
	least square estimation ,Different types of regression curves, scatter diagram, correlation	
	And correlation coefficient, statistical definitions, time series, exponential smoothing	
	technique, ARIMA model.	
3.	Planning Principles and Planning Criterion	5
	Basics of planning, Voltage criteria, Loading and stability criteria	
4.	Generation Planning	3
	Relationship between capacity reserve and reliability, Reliability technique, Cost	
	Evaluation technique Capacity resource planning	
5.	Transmission and Distribution Planning	5
	Selection of transmission corridor, Selection of voltage level for transmission	
	and distribution, secondary distribution system, feeder and distributor, Reactive	
	power planning, series and shunt capacitor, capacitor sizing, Rural electrification	
6.	Economic Planning	4
	Objective of economic planning, Mixed economic, Rural electrification investment, Credit	
	Risk assessment, Rational tariffs	
7.	Tendering and Contracting	3
	Objective, Project planning, Form of tendering, planning and design, General technical	
	specifications, Tendering period and evaluation of tender	
8.	Reliability Analysis	9
	Definition of reliability, reliability indices, outage classification	
	<b>Reliability functions:</b> Reliability functions f(t), F(t), R(t), h(t) and their relationships –	
	exponential distribution –expected value and standard deviation of exponential distribution	
	– Bath tub curve – reliability analysis of series parallel networks using exponential	
	1 distribution – reliability measures MTTF,MTTR,MTBF.	
	Markov modelling: Continuous Markov processes, evaluation of time dependent and	
	limiting state probabilities for one component repairable	
	<b>Network modelling and reliability analysis:</b> Analysis of Series, Parallel, Series-Parallel	
	networks-decomposition method.	
	<b>Frequency and duration techniques:</b> Frequency and duration concept – evaluation of	
	trequency of encountering state, mean cycle time, for one, two component repairable	
	models. Approximate system reliability evaluation for two component repairable series and	
	parallel system.	
	Distribution system reliability analysis: Weather state modelling	
	TOTAL	39L+13T

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Date: 04/10/2021

#### Text Books:

- 1. **Reliability Evaluation of Power Systems**, RoyBillinton and RolandAllan,2<sup>nd</sup> Edition, Springer India Pvt.Ltd. New Delhi, 2008, ISBN:978-81-8128-321-4
- 2. **Introduction to Time series Analysis and Forecasting**, Douglas Montgomery, C.L. Jennings and M.Kulahci, 2<sup>nd</sup> Edition, John Wiley &Sons, ISBN: 978-1-118-74511-3
- 3. Electrical Power Systems Planning, A.S.Pabla,1<sup>st</sup>Edition,MacmillanIndiaLtd,1998,ISBN:0333930673)

#### <u>Reference Books:</u>

- 1. **Power System Planning**, R.L. Sullivan, McGrawHill, 1977, ISBN-10:0070618003
- 2. Modern Power System Planning, X.Wang &J.R. McDonald,McGrawHill,1994,ISBN-10:0077074149.
- 3. **New Computational Methods in Power system Reliability**, D.Elmakias, 1<sup>st</sup>Edition, Springer, 2008, ISBN-10:3642096573.

Kombe Des (Blattackarya)

## **COREELECTIVE-II**

## Advanced Programming for Electrical Engineering(EE4221)

Prerequisites: Introduction to C Programming and Programming Environment

Veekly o	contact: 3-0-0(L-T-P) Full Marks-100	Credits:3
Module No	Module Name and Topics	No. of Lecture-Hrs
1.	<b>Types of Data sharing:</b> Shared memory, Socket programming under UNIX/LINUX and C environment	7
2.	Advanced topics in numerical computation: Eigen value computations, Sparse Matrix, Ordering, Partitioning and relevant topics	7
3.	<b>Basic of Parallel processing:</b> Parallel Programming and Message Passing Interface(MPI)	4
4.	<b>Familiarisation with Pyth on Language:</b> Python Data types, numbers, Python numbers and strings, index, slice. List, dictionaries, tuples, set etc. Python object and DSA Running Python code on Jupiter.	4
5.	<b>Basic Network protocols for LAN &amp; WAN:</b> TCP/IP services - DHCP, DNS, HTTP, SSL, Telnet, ftp and ssh	3
6.	<b>Web Base application development:</b> using HTML/JAVA or some other advance Scripting languages, concepts of digital certificates, signature etc.	5
7.	<b>RDBMS–Concept:</b> SQL—DDL, DML, DCL; concept of functions, triggers and PL /SQL	9
	Total	l: 39L

Text Books:

- 1. Computational Methods for Electric Power Systems, M.L.Crow2<sup>nd</sup>Edition, CRCPress
- 2. Numerical methods, J.H.Mathews2<sup>nd</sup>Edition,PrenticeHallofIndia
- 3. WebTechnologies, A.S. Godboleand A. Kahate, TataMcGraw-HillEducation, ISBN 1259083241, 9781259083242
- 4. **UNIX Network Programming,**W.R.Stevens,2004,Addison-WesleyProfessional,ISBN0131411551,9780131411555
- 5. **SQL,PL/SQL the Programming Language of Oracle**, IvanBayross,4<sup>th</sup>revisededition,BPB Publications, ISBN: 9788176569644, 9788176569644

Kombe Des (Blettackarge)

Date: 04/10/2021

#### DEPARTMENT OF ELECTRICAL ENGINEERING INDIAN INSTITUTE OF ENGINEERING SCIENCE AND TECHNOLOGY, SHIBPUR P.O. BOTANIC GARDEN, HOWRAH-711 103, W.B., INDIA Departmental Elective for 8<sup>th</sup> semester, EE (New Regulation)

## **Big Data Analytics in Energy Informatics (EE 4222)**

Prerequisite: Basics of Power Systems and statistics Weekly contact: 3-0-0 (L- T- S) Full Marks-100

Sl. No.	Module Name	No. of
01	Big Data Analysis for Power System :	
01	Key Challenges, consumer, utility and industry perspective, Big data architecture and platforms, data structure, storage, standards and regulations	IUL
02	Big data Applications for Power System	5L
	Energy Management, state estimation, stability, reliability, operation, control, forecasting and visualization.	
03	Introduction to Energy Informatics	5L
	Energy, AI and sustainability, data driven approaches, role of Information and Communication Technology(ICT) in power and energy sector, Energy Informatics, Internet of Energy	
04	Evolution of Energy Efficient Power Grid :	5L
	Conventional vs. Smart Power Grid , challenges and opportunities,	
	penetration of renewable energy and new dynamics of power system,	
	sensors and smart Meters, Big data generation	
05	Computational intelligence and Algorithms :	8L
	Statistical and Machine Learning based algorithms for clustering,	
	classifications and regression, feature extraction, feature selection, data	
	mining, time series analysis, optimization;	
	Block chain Technology in energy-cost efficient system operation	
06	<b>Demonstration of</b> data-driven approaches, and analysis in power and energy sector	6L
	TOTAL	<b>39L</b>

#### **Suggested Readings:**

- 1. Big Data Application in Power System, Reza Arghandeh et. al, Elsevier, 2018
- 2. AI, IoT and Renewable Energy, Shaw, R.N., Mendis et. al., Springer, 2021
- 3. Intelligent Paradigms for Smart Grid and Renewable Energy, Balasubramaniam, V.K. et.al., Springer, 2021
- 4. Big data analytics in smart grids: state-of-the art, challenges, opportunities, and future directions, Bishnu P. Bhattarai1 et. al., IET Smart Grid, 2019
- 5. Information Systems and Environmentally Sustainable Development: Energy Informatics and New Directions for the IS community,

by R. T. Watson et al., MIS Quarterly, 2010

- 6. Advances and New Trends in Environmental and Energy Informatics, by J. M. Gomez et. al., Springer
- 7. Energy Informatics: Fundamentals and Standardizations, by B. Huang et al., ICT Express(Elsevier), 2017

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Date: 04/10/2021

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#### Digital Communication in Electrical Systems (EE4223) Prerequisites: Basic courses on Digital Electronics, Microprocessors and Microcontrollers

Weekly contact : 3- 0- 0 (L-T-P)

FullMarks-100

Module No.	Module Name and Topics	No. of Lecture- Hrs
1.	<b>Introductory concepts of Digital Communication</b> : Sampling theorem, Quantization, Serial /Parallel,Synchronous/Asynchronous,Wired/Wireless,BaudRate,Time/FrequencydivisionMulti plexing,FrequencyShiftKeying,DigitalModulationtechniques.(Amplitude, Frequency, Phase)	6
2.	<b>Cabling and Interference</b> : Copper based cable, Coaxial cable, Twisted pair cable, Fiber opticcable, Definition of noise, Frequency analysis of noise, Source of electrical noise, Electricalcouplingofnoise, Shielding, Cableducting, Cablespacing, Earthing and grounding requirement, Suppression techniques.	
3.	<b>Serial Communication</b> : Different Protocols-RS232C, RS422,RS485, 20mA current loop,I2C, ZigBee, USB, Blue Tooth, Mobile Communication	8
4.	<b>Computer Communication</b> : Network Topologies, Basic concepts of LAN, Ethernet, Wireless LAN, Internet, TCP/IP, 7 layer OSI model, IoT.	6
5.	<b>Industrial Communication Interface</b> : MODBUS, CANBUS, PROFIBUS, HART, Field bus and Device Net system.	5
6.	<b>Applications in Power Engineering</b> : IEC61850, Power Line Communication, Smart metering, other recent developments	10
	Total:	39L

#### Text Books:

1.**Digital Communications: Fundamentals and Applications,** B.Sklar and P.K.Ray,2<sup>nd</sup> edition,2014,Prentice Hall *Reference Books:* 

- 1. Digital Communication Systems, SimonHaykin, 2013, Wiley
- 2. Electronic Communications System: Fundamentals Through Advanced, W.Tomasi, 5<sup>th</sup>edition, 2013, Pearson
- 3. Wireless Communications: Principles and Practice, T.S. Rappaport, 2<sup>nd</sup>edition, 2010, Pearson
- 4. Computer Networks, A.S.Tanenbaum, 5<sup>th</sup>edition, 2011, -Pearson
- 5. Data Communication and Networking, Forouzan,5<sup>th</sup>edition,2017.ScienceEngineering&Math
- 6. Industrial Communication Technology Hand book, R. Zurawski(ed.), 2<sup>nd</sup>edition, 2017, CRCPress
- 7. IEC61850-Based Smart Substations: Principles, Testing, Operation and Maintenance, Yuan and Yang(ed.),1stEdition,2019,Academic Press,.

#### Web resources:

- https://pdhonline.com/courses/e497/e497content.pdf
   PDH online Course E497(3PDH), Industrial Communications and Control Protocols By Michael J.Hamill,P.E.
- 2. https://doi.org/10.1155/2017/9324035Internet of Things: Architectures,
- Protocols, and Applications, Pallavi Sethi and Smruti R. Sarangi 3. https://www.webopedia.com/quick\_ref/OSI\_Lavers.asp
- https://www.wedopedia.com/quick\_rel/OS1\_Layers.asp
   https://www.tutorialspoint.com/ data\_communication\_computer\_network/
- data\_communication\_computer\_network\_tutorial.pdf
- 6. https://nptel.ac.in/content/storage2/courses/106105080/pdf/M2L2.pdf
- 7. https://nptel.ac.in/content/storage2/nptel\_data3/html/mhrd/ict/text/106105081/lec20.pdf
- 8. https://nptel.ac.in/content/storage2/courses/108105057/Pdf/Lesson-26.pdf
- 9. https://nptel.ac.in/content/storage2/courses/106105080/pdf/M5L8.pdf
- 10. https://nptel.ac.in/content/storage2/nptel\_data3/html/mhrd/ict/text/106105166/lec12.pdf
- 11. https://www.swarthmore.edu/NatSci/echeeve1/Class/e91/Lectures/E91(10)Serial.pdf

Kowhe Das (Blattackarya)

Date: 04/10/2021

## **Elective-II (Open Elective)**

## **Electricity Conservation and Environment Management (EE4261)**

#### **Prerequisite:** None

Weekl	y contact: $3 - 0 - 0$ (L-T-S) Full Marks-100	Credits:3
Module No.	Module Name and Topics	No. of Lecture-Hr.
01	<b>Introduction</b> : Concept of energy, energy scenario, conversion of energy to electrical form, energy and society, review of conventional and non-conventional energy sources and their potential, electrical energy generation, distribution and utilization pattern.	08
02	<b>Pollution and Control:</b> Type of atmospheric pollution (air, water, noise, radiation, etc). Industry wise pollutants, pollution from conventional power generating stations/ sources, & automobile, pollution from nuclear power and uses of PV cells	05
03	<b>Environmental Analysis:</b> Environmental change, ecosystem, resource depletion, effects, Land use - Government action and Environmental Organization	05
04	Electrical Energy utilization: Concept of energy efficiency of electrical appliances. Installation, repair and general maintenance of appliances for efficiency improvement.	03
05	Energy Management: Load dispatch mechanism and energy management at regional and national level, load scheduling, SCADA and EMS.	03
06	<b>Conservation Methods: Institutional role of energy</b> <b>conservation, related case studies.</b> In transmission and distribution, electric power drives, traction, lighting, heating, refrigeration and airconditioning, agricultural appliances.	08
07	<b>Energy Conservation &amp; Environment Protection policy:</b> General awareness energy police and planning economics of energy management, Kyoto protocol, CDM, Carbon Capture and related topics	04
	Total:	36

#### Suggested Reading:

- 1. Energy Management and Conservation Handbook, Edited by: Frank Kreith & D.Yogi Goswami, Publisher : CRC press
- 2. Handbook of Energy audit and Environment Management , Edited by: V.P Abbi & S. Jain, Publisher : Teri
- 3. Carbon Capture, Storage and utilization, Edited by: Nalti Goel, M . Sudhakar & RVShahi, Publisher : Teri

Kombe Des (Blettackarye)

Date: 04/10/2021

## Practical/LaboratoryB. Tech Project Part2 (EE4291)

Weekly contact (0-0-2)(L-T-P)

Full Marks-200

**Credits-8** 

The work is primarily the continuation of the work undertaken as B.Tech Project Part-1 (EE4183).The candidate should work either alone or in groups as assigned by the Department in the seventh semester under B.Tech Project Part-1 (EE4183). Each group will submit project-report in printed and bound form. The report will embody the results of work and should include also the review work and further theoretical/experimental/simulation based studies. The purpose of this project-work is to intimate the candidate into realm of critical study.

## Seminar (EE4292)

The candidate will present a seminar on the B.Tech. project-work, and appear for viva-voce at the end of semester.

Kombe Des (Blettackarye)